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THE BUSINESS OF MINING

BY

ARTHUR J. HOSKIN, M.E.

HARVARD ENGINEERING SCHOOL

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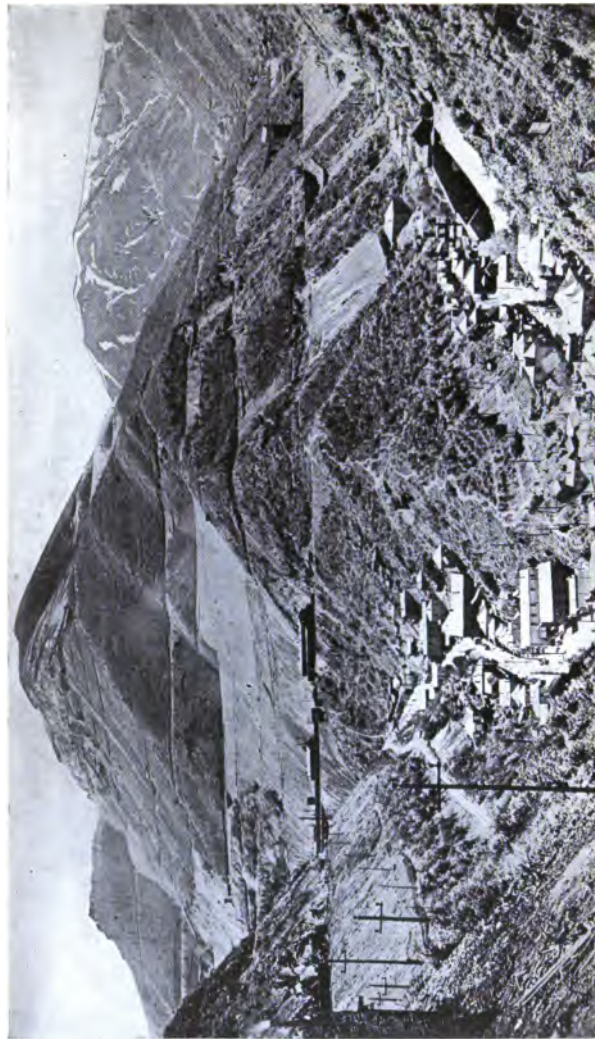
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UTAH COPPER COMPANY'S OPEN PIT MINE, BINGHAM, UTAH.
This Mountain is Copper Ore.

TN
° 153
H7

THE BUSINESS OF MINING

A BRIEF, NON-TECHNICAL EXPOSITION
OF THE PRINCIPLES INVOLVED IN THE
PROFITABLE OPERATION OF MINES

BY

ARTHUR J. HOSKIN, M.E.,

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WITH 16 FULL PAGE ILLUSTRATIONS AND ONE CHART



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THE BUSINESS OF MINING

INTRODUCTION

There is probably no line of human activity that is not beset with malicious and ignorant intruders. The fact that any occupation or business is really legitimate seems often to stimulate the operations of these disreputable persons.

Mining does not escape the application of this postulate. For ages, the industry has afforded most fertile opportunities for the machinations of the unscrupulous and the erring. Somehow, there weaves throughout the history of mining a sort of magnetism rendering us unduly susceptible to the allurements which are presented with every mining proposition.

It is not, however, always intentional deceit that is perpetrated upon the unwary. Often, mining failures result from actual ignorance of the business upon the

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part of those entrusted with its conduct, or if not from actual lack of knowledge, then from erroneous conceptions with the consequent misapplication of honest endeavor. A victim of such misplaced faith is perhaps more leniently inclined than is the person who has been duped by a "shark," but the effect upon the great industry is hurtful in either case.

The purpose of this short monograph will be served if the author can feel assured that his readers will finish its perusal with the belief that mining may be followed as a business with just as much assurance of success as attaches to any one of the many lines of industrial activity. Many persons who have sustained losses in mining ventures deserve no sympathy whatever, since they have not exercised even the simplest precautions. So long as men—or women—will take as fact the word of any untrained or inexperienced individual concerning investments, just so long will there be resultant financial losses, no matter what the line of business. Because there have been elements of chance observed in the

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records of mining, this business appeals to the speculative side of our human natures, with the result that untold numbers of individuals have had ample reason to regret their ventures. But, as will be found in the text matter, mining can be relied upon with precisely as much assurance as can any other business.

Nothing of a technical or engineering sort has been attempted herein, the sole aim of the writer being to establish the reliability and the credit of the mining industry as a whole by pointing out the lines of conduct which should be followed by those who enter its precincts as business people. When investors of small or large means will put their money into mining projects with the same precautions that they would exercise in placing their cash in other enterprises, they will be rewarded with corresponding remuneration. In this firm conviction, then, this little work is dedicated to the intelligence of American laymen in mining matters.

I

WHAT IS A MINE?

Before entering into a discussion of the economic features of the mining industry, it will be well to be sure that we understand, definitely, what is meant by mining. As one investigates the question, he is bound to run across varying shades of meaning for the words *Mine* and *Mining*, and so we must pause long enough to define these words according to the best usages.

A search through works on mining written at various periods reveals differing ideas that have prevailed among authors. Less than a hundred years ago, it was said that a mine "consists of subterranean workings from which valuable minerals are extracted." One early writer said that a mine is one only when the operations are conducted in the absence of daylight. As time has created

WHAT IS A MINE?

new fields for the industry, we find that ideas concerning the meaning of the word mine have necessarily altered, until now (according to The Coal and Metal Miners' Pocketbook), we may think of a mine as "any excavation made for the extraction of minerals." Under this definition, we properly think of the rather unusual operations of marketing coal right from the surface of the earth, in eastern Kansas, as mining. There is, in this case, no covering of earth above the workmen; neither are the operations necessarily carried on at night to avoid the illumination of the sun.

So, also, placers are now correctly spoken of as mines, although but a few years ago there was drawn a strict line, eliminating such worked deposits from the category of mines. One may still run across a few men who are sticklers upon the point that a placer is not a mine. Throughout the world, at the present time, there are many places where immense deposits of valuable minerals are being excavated from open pits by out-of-doors methods, and our common

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term for these places is mines. Thus, in Minnesota, in that wonderful Lake Superior country, that is famous as the world's greatest known producer of iron ore, tremendous tonnages are handled every year by the modern steam shovel, which works in natural light by day and by electric lamps at night. In Utah and Nevada we find similar operations conducted in the excavation of copper ores. In Australia, the famous Mount Morgan mine is using open air methods in the mining of precious metal ore.

But what about quarries from which are taken building stone, salt, kaolin or clay? Are not such substances of the mineral kingdom? Here we run across a hitch in the definition quoted above; for while we hear of "salt mines" (not "salted mines"), our parlance has not, as yet, warranted this term except for such excavations of salt as are carried on in subterranean deposits; and it is quite out of place to speak of stone or clay mines.

Evidently we must pass through another transition in our conceptions about mines, or we must permit quarries and

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pits to be included within our realm of mines. At the present time, the prevailing practice of the men best qualified in such matters is to designate as mines those workings from which only coal, metallic ores, or gems are extracted. Hence, we should not speak of a slate, sulphur, mica, clay or phosphate mine.

And yet, with all the above restriction in our nomenclature, we have not reached one very important consideration, one which we have been approaching for a number of years and which, of late, has been met and forcibly applied by the best men in the profession of mining engineering.

An excavation that will produce coal, metals or gems is not necessarily a mine. The simple fact that a man can get some gold-bearing dirt from a hole in the ground does not mean that he has a mine. The occasional finding of a diamond on the sidewalks of a great city does not give anybody the impression that city sidewalks are diamond mines. There are many places in which small amounts of combustible coal can be scratched from

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its natural depository, but no company appears to think highly enough of these seams to install machinery and to carry on operations. In the eastern part of Kentucky there are well-defined deposits of lead-bearing baryta, though, up to date, their development has not proved successful. In Brazil there are known to be very rich areas of placer ground, and still the deposits are not worked. A friend of the writer discovered some very good gold-bearing gravels in Alaska, but he was unable to mine.

There is something besides the presence of valuable minerals and the ability to win them from their natural matrices that is essential to a mine. It is here, in our considerations of the mining industry, that we come into real economic notions for the first time. Yes, according to the latest ideas, we are wrong in stating that any worked or workable mineral deposit is a mine, *if it does not contain possibilities of profitable working*. This is now the prime thought of every up-to-date mining manager or engineer. It is this notion that will distinguish a mine from a pros-

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pect. The prospect may become a mine by proving itself profitably workable: if it simply carries values which cannot be realized to advantage, then it must continue as a mere prospect. There are cases of properties which possess rich deposits and which are loosely called mines. These properties may be observed to be erratic in their productiveness, owing to the very pockety nature of the deposits; and the owners, although they do, indeed, strike occasional handsome bonanzas, expend all the profits of such finds—or even greater amounts—in searching for other pockets. Is such work profitable? Is it mining?

The trouble with the cited placers of South America is that climatic, hygienic and political conditions have been antagonistic to successful working: the ground is rich, but it cannot be handled to make money. In the case of the Alaska gravels, there was no available, though essential, water supply. The Kentucky galena cannot be economically separated from the containing heavy spar. Coal, which is sold at comparatively low figures per

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ton, must be handled at the mines in large quantities to pay, so that a thin seam or a scattered deposit is not suitable for mining.

Under these restrictions of our new definitions, we run across many interesting points. For instance, one may ask the question about the old abandoned hole in the ground which is occasionally found by prospectors, "Is it a mine?" The answer can be simply another query as to whether the hole was abandoned because it contained no value, or because, containing value, it could not be profitably worked. As we think of mines nowadays, we can conceive several reasons why, before the advent of transportation lines and the invention of modern metallurgical processes and many forms of labor-saving machinery now so common in and about mines, many very rich deposits may have been necessarily forsaken by their discoverers. But such a property would, if now worked, probably prove highly profitable. We thus note that there exists some elasticity in the meaning of the word mine. An unprofit-

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able project at one time may develop into a mine at a later period. Many gold mines have become worthless propositions merely through changes in the ore that have rendered further work unremunerative.

II

WHAT IS MINING?

Having considered the accepted definition of a mine, let us now extend our reasoning a little and inquire just what is meant by mining. At first thought, one would say that mining is, in a broad sense, the art or practice of excavating, at a profit, the ores of metals, the beds of coal, the gravels of placers and the deposits containing precious stones. Are we justified in letting this definition stand as it is? If we do not make any change, we must exclude all quarries, sand banks, clay pits, and the numerous sorts of works that are producing the non-metallic minerals of commerce. Very well, since we find good usage will warrant us, we will do so.

Still, there are other pertinent questions arising. Does the practice of mining cover the treatment of the excavated products? Here we run across a mooted point. The British and the American



HACKETT MINE AND MILL, JOPLIN, MISSOURI.

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uses of the word mining seem to be a bit different in this regard. Upon the Rand, South Africa, a territory dominated by Englishmen, every mine is equipped with its own mill, and all notions of mining cover the inseparable idea of local ore treatment. Here, in our country, there are many, many mines which have absolutely no means of treating their own products and the managers give no thought whatever to metallurgical or milling lines. There are, on the other hand, many companies that have erected private plants at their mines for the extraction of metallic contents from the ores. Here it may, or it may not, happen that the operations of mining are considered as distinct from those of treatment. In some instances, as at the Tonopah Mining Company's plants, there is separate superintendence of the milling and the mining; but in the Joplin, Missouri, zinc region one superintendent looks after the running of a mine and its omnipresent mill.

There may be drawn a sharp distinction between what is really mining and what is

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the subsequent treatment of the ores for the extraction of values. The latter field is denoted *Metallurgy* when the operations are of such a nature as to actually recover or extract metallic products or metals. If the treatment process has for its object merely the rejection of some of the worthless materials in the original ore, thus causing a concentration of the valuable minerals, but without actually obtaining any metal, then the term *Ore Dressing* is warranted. At some mines, there is maintained a practice of culling out, often by hand, a certain percentage of the obviously worthless ingredients of the ore before shipping the products to treatment plants. This is neither milling, metallurgy, nor ore dressing, but is more properly called *Sorting*. It is one of the operations connected with mining. Milling may be either ore dressing or metallurgy.

In the operations of placering, there is a simultaneous *excavation* of a deposit and an *extraction* of the valuable contents. In this case, shall we call the process mining or metallurgy? If it is a gold

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placer, one may see the recovery of the metallic values. Here, the usage of the majority of practical mining men will uphold us in always speaking of the work as mining.

In its original significance and use, metallurgy involved the use of fire for the concentration and recovery of metals. With recent advances in chemistry, there have been numerous discoveries of wet or fireless methods for arriving at equivalent results, so that it is now perfectly proper to allow the word metallurgy to cover such processes as cyanidation, chlorination, electrolysis, and the host of new inventions that are continually appearing.

The writer has consulted a number of authorities on mining lines to ascertain just what sort of a position to give to the practice of ore dressing. Prof. Robert H. Richards, the head of the mining department in the Massachusetts Institute of Technology, and the inventor of machines which have made him famous among mining men, says, "Ore dressing is an essential part of mining. The whole object of ore dressing is to remove gangue

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before shipment and so save in freight and treatment charges." Mr. A. G. Charleton, the eminent English mining engineer and author of numerous books, in discussing this question, writes, "Personally, I am of the opinion that ore dressing should be included in mining." One has but to look through the catalogues of most of the American and foreign mining schools to find that little or no line is drawn between the courses in mining and metallurgy, and almost universally the dressing of a mine's product is taken up as an inseparable part of mining. In a very few exceptions, the courses of study are so planned as to draw an imaginary line between mining and metallurgy, and in these instances, ore dressing is placed with metallurgy only for convenience in the use and arrangement of college laboratories. But, since it is a common practice for mining companies to install plants right at the mines for the purpose of diminishing the bulk of ore shipped and to thus save in freight and custom treatment charges, mine superintendents and even the com-



COAL WASHING PLANT, PANAMA, ILLINOIS.

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mon miners have become accustomed to thinking of such plants as but units of the "mining" plants. At bituminous and anthracite mines whose products contain objectionable amounts of impurities, it is a common practice to subject the output to a *Washing* to remove the deleterious substances before shipment to the market.

In view, then, of these reasons, it is proper to decide that mining is a term broad enough to cover the operations of extracting coal and metallic ores from the ground and of preparing them for shipment or metallurgical treatment.

Coal is always coal, no matter in what thickness of deposit it is found. It may not be minable coal because in thin seams or because so intercalated with layers of slate or "bone," that the mine's mixture, or so-called "run of mine," is not salable. But with metallic ores, we run across an idea that is occupying the attention of many prominent geologists and mining men.

What is ore? This is a question to which there have been many attempted

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answers. There has been an evolution of ideas, with a corresponding gradation of definition. To set a uniform standard of thought upon this point, officers of the United States Geological Survey, a few years ago, proposed the following definition. It must be conceded that this definition, while embodying many splendid features, is not altogether exempt from criticism; but in the absence of anything better, we shall not be very far in error if we use it:

Ore is a *natural* aggregation of one or more *minerals* from which useful *metal* may be *profitably* extracted.

There is, then, no such thing as "pay ore" or "non-pay ore," expressions still quite common among miners and prospectors of the uneducated types. Prof. James F. Kemp, probably America's best-posted writer upon the subject, in an attempt to formulate one acceptable and unchangeable meaning for the word ore, says, "In its technical sense, an ore is a metalliferous mineral or an aggregate of such minerals, more or less mixed with gangue, and capable of being won and

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treated at a profit. The test of *yielding the metal or metals at a profit* seems to me, in the last analysis, the only feasible one to employ." This definition eliminates one of the weak points in the first definition, namely, that an ore must be an association of minerals: there are some common ores (as for example, magnetite) which are not associations, but single minerals.

We now reach certain fundamental concepts which must be accepted by the mining man who desires to be recognized as abreast of modern ideas. Following the publication of Kemp's definition of ore, there was much comment—as was anticipated—with the result that there has been noted a vacancy in scientific matters and it has been thought proper to permit another definition for purely scientific uses. This other definition of ore will cover the materials or aggregates of minerals from which gem stones and other valuable, but not metallic, substances are recovered.

Let us recapitulate. An *ore* must be an aggregate or association of natural

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minerals, or a single mineral, from which metal may be profitably recovered. *Mines* are excavations in the earth from which ore, coal or gems are taken. *Mining* is the art or practice of operating mines.

Throughout the subject, we see the inseparable idea of *profit*. The work of carrying on operations in a railroad tunnel is not mining; the driving of adits through barren rocks to reach ore bodies is not mining; the sinking of shafts through worthless "wash" or rocks with a view of opening avenues for the removal of ore is not mining. Mining is carried on only when ore is being produced. The wildcat practice of erecting small, temporary plants and digging prospect holes can be condemned as not being real mining.

There is usually little question about the validity of a coal mining proposition, since "the goods show for themselves." Comparatively few cases of fraudulent ventures in coal properties are of record. The product of a coal mine is ready for market just as soon as it is loaded into railroad cars, the mining company receiv-



UNIVERSAL MINE (BITUMINOUS), CLINTON, INDIANA.

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ing its pay, commonly, upon its own recorded weights. There is no freight to pay, no waiting for assays or analyses, and no settlements with mills or smelteries. There are not the allurements for getting rich quickly in coal mining that are so beguiling to the class of investors generally approached by the promoters of mines(?). This must not be construed as stating that nobody has ever been deceived in a coal mine proposition, for, indeed, there have been many failures; however, they have been due, chiefly, to auto-deception as to area, thickness or quality of the coal measures.

III

THE ANTIQUITY OF MINING.

Mining is believed to have been one of man's earliest occupations. In historical writings, many of which date back into antiquity, there are allusions, as well as direct statements, concerning the art and tasks of obtaining valuable metals from Mother Earth. We are told that the very ancient Egyptians made common use of metals and that they possessed knowledge of certain metallurgical and metal-working processes (as for example, the tempering of copper) which we, of today, cannot claim. Six thousand years ago Egypt became a world power through her mining of copper in the Sinai Peninsula. Iron implements found in the great Gizeh Pyramid are supposed to date back to 4,000 B. C. Copper tools have been found in the ruins of ancient Troy. In Assyria, a very good steel saw, 44 inches long, was taken from the ruins of Nimrod. Iron was utilized by the Chinese some

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2,000 years B. C. Near Delhi, India, there exists an iron pillar, 22 feet long and weighing six tons, dating back to 400 B. C. It is chiefly interesting in exhibiting an ancient knowledge of welding which is the envy of our modern iron workers. If we accept the Hebrew Scriptures, we must believe that mining was carried on in the time of Tubalcain, spoken of in Genesis. The Old Testament contains numerous verses referring to the mining of metals, the land of perfect abundance being paraphrased in Deuteronomy thus: "Where the stones are of iron and out of its hills are digged mines of brass." Coal was mined and used in Greece in 1330 B. C.

It is quite probable that gold was the earliest metal to be worked. There are two good reasons for this assumption: First, gold was to be found in the native state or as nuggets, thus requiring no reduction process. Second, the ores of gold are usually less refractory than are the ores of other metals. This is especially true of the oxidized ores such as would naturally be discovered by prim-

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itive man. These facts, together with the further properties of gold, *viz.*, that its color is attractive, that it resists corrosion or tarnish, and that it is easily worked into ornaments or coin merely by hammering, make it highly probable that humans early made use of this yellow material.

We read in Job 28:1, that "gold is refined;" and modern investigations tend to prove that the Ophir of Biblical reference is the southern portion of Matabeleland or the Rhodesia of present fame among mining regions. It is possible and quite probable that the great quantities of gold used in the building and furnishing of King Solomon's Temple came from the vicinity of the present city of Johannesburg. The "golden fleece" of literature has been explained as a figure of speech for the skins of sheep which were laid in troughs to catch gold upon the principle of the riffle in a modern sluice-box.

Copper was perhaps the second metal to be worked by man. As a rule, it, also, is easily smelted from its ores; and, as above mentioned, we have relics that

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give evidence of wonderful skill in working this metal in times of remote antiquity.

However, other metals are believed to have been mined, upon commercial scales, before the Christian era. Silver and lead were handled in large quantities from the mines of Laurium, Greece, in the sixth century B. C., and the same mines are being worked to this day, the principal values now being in the lead rather than, as formerly, in the white metal. The Phœnicians, about 500 B. C., invaded Spain for gold, copper and mercury, and Cornwall for tin and copper. The Almaden quicksilver mines of Spain have been operated, almost incessantly, since 415 B. C., and in the 16th century, A. D., the wealth of Europe's greatest family of financiers, the Füngers, was based upon the operation of this remarkable deposit.

Del Mar, in his *History of the Precious Metals*, says, "Desire for the precious metals, rather than geographical researches or military conquest, is the principal motive which has led to the dominion of the earth by civilized races. Gold has invariably invited commerce,

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invasion has followed commerce, and permanent occupation has completed the process. It is the history of the past as well as of the present. Scipio went to Africa, Cæsar to Gaul, Columbus to America, Cortez to Mexico, Pizarro to Peru, Clive to the conquest and Hastings to plunder Bengal."

Our own day has witnessed the subjugation of the Boer. Because of Mexico's mineral wealth, many optimistic Americans are beginning to prophesy the annexation of our sister republic. For gold, Englishmen populated Australia in 1850, about the same time (1849) that we witnessed the rush to California gold fields. Spaniards settled Central and South American countries merely to gain the precious metals. It is mining which has been responsible for the population of the arid, southwestern portion of our own domain.

In this, as in every other age of the world's development, we shall find that the mining industry lies at the heart of all commerce. It is well for the student of mining economics to fully appreciate

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this fact, for it will whet his interest in this great world industry.

“Truly, it has been a great seeking and finding. The story of mining may have been staled by commonplace, and the romance of it dulled, often enough, by greed; yet, in the main, it has linked the generations of earth as with a golden thread—and if not golden only, then there has been the red glint of copper or the white sheen of silver. Mining districts may come and go, but mining remains.”
—(Editorial, *Engineering and Mining Journal*).

IV

MINING'S PLACE IN COMMERCE.

It is said that upon two of the world's commercial industries, every other form of activity depends. These two fundamental industries are agriculture and mining. Statisticians prove the above statement and the further fact that these two dissimilar branches of civilization's business are so closely related as to be quite inter-dependent. Strides are made by one of these industries only when advance is noted in the other. While it may not be possible to explain just why this is so, it is worth our attention to consider some brief figures that show this condition of affairs.

The agitation conducted during the past few years, leading to the establishment of a Bureau of Mines in the Department of the Interior, attracted the thoughts of many students of economics who had not previously or seriously considered the industry of mining. The

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delivery of brilliant addresses showed that mining had been unjustly retarded. While agriculture has for years been fostered by the government and with remarkably satisfactory results, the great sister industry has been required, until recently, to struggle along without any governmental recognition in the matter of support. Yet it has forged its way in unmistakable terms of progress and there was an insistent demand, among those men particularly interested in the welfare of mining, for the protection and the assistance which would and has now come through the establishment of a governmental department. Various states have long recognized the importance of the mining industry by the establishment of departments. The Canadian and Mexican governments maintain very creditable Departments of Mines. It was but a question of time until the shortsightedness of our politicians (not our statesmen) was revealed, and the mining industry has now come under the auspices of a federal department.

Taking the world as a whole, it would

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be hard to conceive the sum total of annual mineral productions. The middle of the past century seems to have been a critical period in the mining industry of the earth. There was a great impetus given to mining by the greed for gold which caused the settlement of our western states and the Australian states, as already mentioned. But there gradually followed the opening up of mining in many other and hitherto unpopulated and uncivilized portions of the globe. The search for gold was successful.

Prior to 1850, the production of gold had not kept pace with the increase in population. Soon, however, it began to take leaps, in almost geometrical ratios, until, by 1900, the annual production of gold throughout the world was some 2,200 per cent. of the production for 1800 (as nearly as may be ascertained). The 1900 gold production was of a weight of about 400 tons, in round figures. During 1911, the world produced approximately \$470,000,000 (about 779 tons) in new gold bullion. It is estimated that with a continuance of the remarkable



KENNEDY MINE, JACKSON, CALIFORNIA.

MINING'S PLACE IN COMMERCE

progress, the next 20 years will duplicate *the amount of gold now known in the world. This means that the amount of gold which has been accumulating from mining during the world's ages will be doubled during a fraction of our lifetime.* This is significant of the world's progress, in gold mining, at least.

It seems coincidental that the rush for gold in 1849-50 should have been almost simultaneous with the remarkable development of our other mineral resources. All of our great discoveries of coal, oil, silver, iron, lead, copper, and zinc can be said to have followed closely upon the discovery of gold in California. It is not supposed that the discovery of iron in northern Michigan in the early eighties had any connection with the "Pike's-Peak-or-Bust" expeditions, nor that the opening and development of the vast coal beds of Pennsylvania had any bearing on the discoveries of lead and zinc in the great Mississippi Valley. But, on the other hand, there can be traced a very intimate relation between the finding of gold, silver, copper, and lead in the

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Rocky Mountain states and the search for gold in California: the pioneers en route to the coast were the discoverers and settlers in Colorado, Wyoming, Utah, and Montana.

Figures are not available for arriving at such striking or reliable conclusions in regard to the world's production of metals other than gold, but there is no logical reason to doubt that such increases have been just as pronounced as in the case of the yellow metal. In fact, there are good grounds for assuming that the figures for silver, lead, iron, and zinc would show up even more spectacularly; while with coal, we know that we are now in the greatest period of the world's production.

The United States leads the world in the production of the base metals, such as copper, iron, manganese, lead, and zinc, taken collectively or separately. Our country stands second in the production of the precious metals, gold, platinum, and silver. We have the greatest variety of mineral products, as well as the greatest production of complex ores, or those carrying more than one valuable metal.

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We produce more copper than the rest of the world combined. Although we stand in second place when considering the production of gold, we still possess the Homestake mine in the Black Hills, famous as being the gold mine with the greatest tonnage in the world; and the Camp Bird mine, in the San Juan district of Colorado, famous the world over for its highest average value of gold ore. This great mine is now nearly exhausted and is about to close down after making a wonderful record.

South Africa produces the greatest amount of, and the purest, natural gold in the world. Great Britain has an insignificant production of both gold and copper, and still it is noteworthy that the English-speaking nations control the world's production of both these metals. British and American citizens own seven-eighths of the world's gold mines. England stands second in the consumption of copper, which, of course, is mainly imported.

Russia controls the world's output of platinum, with very little competition.

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In a similar manner, Canada has the control of nickel production. Mexico, although not commonly regarded as a gold mining country, is rapidly coming to the front and possesses the Esperanza mine, said to be one of the most profitable gold mines in the world.

To more emphatically show the importance of the mining industry, especially in our own country, the following facts are taken from 1900 census returns: Agriculture produces annually about \$725 per capita; mining, \$1,910; and manufacturing, which is dependent upon the others, \$760. *The National Banker* has said: "Statistics show that the combined dividends paid by the gold and silver mining companies of the United States are greater than the combined dividends paid by all of the banking institutions of the country; and the combined dividends paid by the copper mining companies of the United States exceed the combined dividends paid by all of our railroads."

There is one thought that will always comfort any person who is engaged in furthering legitimate mining: Wealth

MINING'S PLACE IN COMMERCE

acquired from a mine is not wrested from any being but Mother Earth, and it is not, therefore, in the class with the much discussed "tainted money" that is said to be wrung from unfortunate human beings.

The following tables are presented to give the reader ideas concerning the productions of gold and silver during recent years. Among the interesting points that may be noted are the following:

The gold production of the world took a sudden drop in 1900, but it immediately resumed its upward climb. During the decade from 1900 to 1910, this production increased over 81 per cent.

There is a remarkable similarity noticeable in the gold productions of the United States during the years 1910 and 1911.

Without the notable increase in the gold output of the Transvaal in 1911, the world's total gold production for that year would have shown a decrease.

The silver production of the United States remained practically unchanged during 1911.

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GOLD PRODUCTION OF THE WORLD FOR 20 YEARS

1892.....	\$146,292,600	1902.....	\$298,812,493
1893.....	158,437,551	1903.....	329,475,401
1894.....	182,509,283	1904.....	349,088,293
1895.....	198,995,741	1905.....	378,411,054
1896.....	211,242,081	1906.....	405,551,022
1897.....	237,833,984	1907.....	411,294,458
1898.....	287,327,833	1908.....	443,434,527
1899.....	311,505,947	1909.....	459,927,482
1900.....	258,829,703	1910.....	469,365,110
1901.....	260,877,429	1911.....	473,383,543

UNITED STATES SILVER PRODUCTION (In Fine Ounces)

	1910	1911
Alabama.....	300	174
Alaska.....	153,900	275,691
Arizona.....	2,655,700	1,594,428
California.....	1,791,600	2,727,336
Colorado.....	8,523,000	7,530,940
Georgia.....	300	225
Idaho.....	7,027,000	7,507,802
Illinois.....	2,100	4,648
Michigan.....	262,200	507,234
Maryland.....		87
Missouri.....	32,200	56,228
Montana.....	12,282,900	11,116,778
Nevada.....	12,366,000	10,651,571
N. Mexico.....	779,000	1,142,335
N. Carolina.....	8,300	2,227
Oklahoma.....		168,245
Oregon.....	43,800	69,116
Pennsylvania.....	700	13,262
S. Carolina.....		14
S. Dakota.....	120,600	206,188
Tennessee.....	69,800	126,683
Texas.....	364,400	442,486
Utah.....	10,445,900	12,679,633
Virginia.....	200	45

MINING'S PLACE IN COMMERCE

UNITED STATES SILVER PRODUCTION—*Continued*

	1910	1911
Washington.....	204,900	142,196
Wyoming.....	1,300	1,009
Porto Rico.....		51
Philippines.....	1,800	3,383
Miscellaneous.....		826,102
Total.....	57,137,900	57,796,117

UNITED STATES GOLD PRODUCTION

(In Value)

	1910	1911
Alabama.....	\$32,900	\$18,335
Alaska.....	16,271,800	16,002,976
Arizona.....	3,413,200	2,954,790
California.....	20,441,400	20,310,987
Colorado.....	20,526,500	19,153,860
Georgia.....	24,000	30,532
Idaho.....	1,035,000	1,169,261
Illinois.....		5,788
Michigan.....		20
Maryland.....		20
Montana.....	3,720,400	3,169,840
Nevada.....	18,783,700	18,968,578
New Mexico.....	477,200	639,897
N. Carolina.....	64,500	76,693
Oklahoma.....		30,698
Oregon.....	681,400	599,235
Pennsylvania.....	5,900	7,814
S. Carolina.....	37,800	18,437
S. Dakota.....	5,380,200	7,430,367
Tennessee.....	2,800	14,140
Texas.....	400	1,178
Utah.....	4,312,700	4,709,747
Virginia.....	900	4,300
Washington.....	806,000	504,537
Wyoming.....	4,100	18,791
Porto Rico.....	1,000	2,191
Philippines.....	154,400	130,501
Miscellaneous.....		265,013
Total.....	\$96,269,100	\$96,233,528

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GOLD PRODUCTION OF THE WORLD

	1910	1911
Transvaal.....	\$155,730,260	\$170,487,900
United States including Alaska.	96,269,100	96,233,528
Australia.....	65,634,340	61,072,409
Russia.....	43,168,389	40,600,000
Mexico.....	24,073,100	19,500,000
Rhodesia.....	12,607,791	13,045,100
India.....	12,089,400	10,505,506
Canada.....	10,224,910	10,646,000
China.....	10,102,300	10,000,000
Japan, East Indies, etc.	10,522,437	10,600,000
West Africa.....	3,674,087	5,268,100
Madagascar.....	2,149,721	1,900,000
France.....	1,114,700	1,275,000
Central and South America....	14,886,234	15,000,000
Other countries.....	7,118,841	7,250,000
Total.....	<u>\$469,365,610</u>	<u>\$473,383,543</u>

V

THE FINDING OF MINES.

Mines are discovered in many ways. One hears much about prospecting, and since this is a practice which is rapidly changing from a mystical to a scientific basis, a few considerations will here be in order.

Persons who have lived in mining communities are familiar with two types of prospector, the roving and the settled. Somehow, when we think of the former, there comes to mind a bearded, roughly clad man, usually accompanied by a "jack" and both packing the outfit consisting of a few tools, a pan, some blankets, a gun, and a supply of "grub." If we have in mind the other type of prospector, we imagine him as living an isolated life in a log cabin up in the hills, spending his daytime in putting in a few, short drill-holes and blasting down a ton or two of usually worthless rock in a

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“tunnel” or shallow shaft, confident that each succeeding shot will disclose a treasure.

Both of these types represent the utmost in optimism. These men endure many hardships and privations, they can have little converse with other humans, often they can see no provisions for the next day; in fact, they receive few of the benefits of modern civilization—if we except the food-preserving features. Still, a typical, old-style prospector keeps on with absolute faith that fortune will smile tomorrow. We must reach the conclusion that these uneducated men are led on by subtle beliefs which, to a technically-trained man, seem like the rankest folly. They are diviners, dreamers. They are disappearing now and, a generation hence, there will be but memories of them. They are giving way to successors of a different type.

The newer kind of prospector is well educated, and, perchance, he is rather youthful. His chances of success are many times those of the man he supplants. Why? Because he is taking

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advantage of the work that has been done by all former prospectors. He is guided by theories deduced from observations through ages, and he has the advice of the best contemporary men of experience in matters of geology as applied to mining. In other words, he is a scientific prospector.

The prospector of today has a general understanding of mineralogy and geology; he must have knowledge of mining methods, so that he may know whether a deposit, once found, can be exploited at a profit; he must be ready to account for all discovered mineral bodies, and he must be capable of applying theories to actualities.

There are so many metals and minerals sought for the markets of the world today that we see there are many fields of study and practice open to prospectors. It is not the purpose here to explain the details of scientific prospecting, for the study of this one subject would, in itself, fill a volume. The object of the above remarks is to draw to the attention of the economist the propriety (amounting al-

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most to a necessity) of giving heed to the findings of the educated, trained searcher for mineral bodies, in preference to those of the illiterate man who has furnished themes for artists, narrators and dramatists, because of his quaint characteristics.

Some writers have classified mineral discoveries into Search, Chance and Adventitious.

Search discoveries, being the rewards of earnest seeking, it is not surprising that, under the past guide of notions and mysticism, the percentage of such discoveries has been small. Under the new order of things, with science as a guide, the percentage is growing and, in the future, this kind of discovery will undoubtedly strongly outnumber the others.

Chance discoveries are those that are made purely without premeditation. They have been a dominant factor in the mineral development of the past. The discovery of *gold* in California came about through the noticing of shiny, yellow flakes of metal in a ditch leading to a saw-mill. The great *iron* mines of the Mesabi Range were found by the ore

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clinging to the roots of an overturned tree. The Wallaroo *copper* mine, the greatest in Australia, was discovered by the green minerals brought to the surface in the excavations of a wombat. The famous Sudbury *nickel-silver* ore bodies were disclosed when making a railroad cut on the Canadian Pacific Railroad. The Reddington *quicksilver* mine, in California, was similarly opened in a cut for a wagon road. The mining of *silver* at Catorce, Mexico, followed the discovery of shining silver nuggets in the camp-fire of a native, who had camped right upon a rich outcrop. The Kimberly *diamond* mines are said to have been disclosed by the burrowings of an ichneumon, which fetched a brilliant stone to the sunlight.

Adventitious finds are such as occasionally occur when, while really searching for, or actually mining, one metal, discovery is made of a different metal, or possibly the same metal is found in an entirely different kind of ore. The Comstock lode of Nevada was originally a *search* gold discovery, the gold having been sought and found by two prospec-

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tors with ordinary gold pans. In their working to recover gold, a black mineral and a yellow sand were discarded from the pans and rockers. Curiosity of one man resulted in the identification of these two minerals as ores of silver which henceforth were held as valuable as the native gold. The Anaconda mine, at Butte, Montana, was located, and for some time worked as a silver proposition; but the values gradually changed with depth from silver to copper, until now silver is only a valuable by-product. The rich lead-silver ores of Leadville were discovered as *adventitious* to the operation of the rich gold placers in California Gulch. A heavy, troublesome rock which accumulated in the sluices, much to the disgust of the miners, turned out to be cerussite, a fine ore of lead. This same district now produces in commercial amounts gold, silver, lead, iron, zinc, copper, and manganese. The Treadwell mine on Douglas Island, Alaska, was first worked as a placer and the values were found to extend downward into the underlying rock in a place which proved

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to be an immense deposit of eruptive, gold-bearing ore.

As the old-fashioned, venturesome kind of prospecting has but recently been crowded off the scene by the better, scientific kind, let us not overlook the great discoveries that were made in the past before we had applied "organized common sense" to such a field of activity. Those original prospectors were searchers, hunters. They had no guides, but they did accomplish a great deal, and their discoveries were rewards for diligence and hard labor which were, to a great extent, often misdirected.

VI

MINING CLAIMS.

The process of acquiring title to mining property may be viewed from a number of points. Such property is real estate and, as such, it may be bought and sold or otherwise transferred exactly the same as farms or city lots.

The United States has constructed an elaborate system for the disposal of its public lands to individuals, under various classifications, such as homestead, desert land, timber and stone, timber culture, coal, placer, and lode claims. Different rules apply to the filing upon, improvement and patenting (acquiring deed from the Government) of these various kinds of claims. The character of the lands in the public domain is decided by the surveyors who execute contracts from the General Land Office for subdividing or staking the country off into townships and sections, according to our American system. In the return of each surveyor's

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notes, he recommends the sale of the land according to his judgment as to its highest value. There has naturally been a good deal of erroneous conception upon these points, with the result that, often, land has been later shown to be entirely different in its character from the classification given to it by the contracting surveyor; for the qualifications of such a person are not always of a high grade, when it comes to geological questions. And yet, on the whole, the scheme has worked out well and much fraud against the Government has been prevented by the rigid practice.

The Government prices for some of the various classes of land have been as follows: agricultural, \$1.25 per acre; coal, \$10 per acre when the land was not closer to a railroad than 15 miles, and \$20 per acre when it lay within this limit; placer, \$2.50 per acre; lode, \$5 per acre. These have been the prices demanded for the land only; the payment of these amounts, in many cases, has constituted a small fraction of the expense of securing the original deeds from the Federal Government.

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Coal lands may be located very much the same as a homestead, with the exception that residence upon the ground is not required, nor are improvements essential. In cases of dispute as to priority of location, the land office will recognize those claimants who have expended the greater amounts in improvements. One citizen may locate but one claim of 160 acres.

Since April 10, 1909, the Government has been disposing of its public coal lands under a classification that takes note of many details. The kind, grade, thickness, and purity of coal; the number of workable seams; the depth; the features of local supply; transportation facilities; and the average prices at which similar private tracts are held, are among the items recognized in the classification. Probably no two tracts will be sold at the same rate. In general, the new prices are higher than the flat prices that formerly prevailed and some pieces of land are now estimated as high as \$175 per acre. In every case of application to purchase coal land, hereafter, the area in question will undergo inspection by Government

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experts and a price will then be assessed.

This law is being severely opposed as being unreasonably severe, and its amendment may be looked for.

Placer lands were formerly permitted to be taken up in any shape, the boundary stakes being placed upon the ground in such a manner as to include only the desirable area, which is usually of an alluvial nature along some valley or gulch. This practice has been forbidden, however, and a locator is now obliged to take up his land in quadrilateral tracts conforming to the subdivisions of the so-called Public Survey. By this rule, it is permissible to file upon land which is laid off into lots of not less than $\frac{1}{16}$ of a quarter section—or ten acres—and a claim may be composed of such lots as lie contiguously and which may thus be considered as one complete workable area. The claims are often of zigzag or L shapes, but the locator is enabled, at the extra expense of subdivision surveying, to avoid filing upon, and paying for, much ground that he feels is not desirable in a placer claim. The Government does not survey

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public domain into smaller tracts than quarter sections of 160 acres each, so that in the taking up of placers it often involves a great deal of expense to carry the subdivisions upon the ground into sufficient detail to ascertain the location of boundary corners.

One person is entitled to as many placer claims as he desires. Each claim of a single individual may contain not to exceed 20 acres and, as said, it must be of one continuous area. Associations of citizens to the number of eight may unite in the location of 160 acres, which will then be held in equal and common interest by the several locators. The restraint placed upon greed in the matter of locations, either placer or lode, lies in certain expenses entailed in work or improvements upon the land before patent may be issued and the legal requirement of the performance of labor upon each claim amounting to \$100 per annum. Also, it is required that *bona fide* values be disclosed upon the ground. For each 20 acres located under the placer laws of the United States, not less than \$500

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worth of improvements must be made before the issuance of a patent.

The legal (not the technical) definition of lode land covers all grounds containing deposits of ore in its natural and original place of deposit. Under the laws, therefore, a citizen may file upon a tract of land to include a vein, lode, mass, chimney or any other form of ore body. The laws were framed at a time when miners were familiar only with the steep, tabular forms, synonymously termed veins or lodes in their nomenclature, and there were introduced features which time and progress in geological investigations have proved to be entirely unsuited to the needs of locators in many districts.

Our statutes provide that a lode claim may not exceed an area of 20,662 acres, this being the area of a parallelogram 1,500 feet long by 600 feet wide. The intention is to permit a discoverer to lay off a "lode line" along the outcrop of his vein for a distance of 1,500 feet and, at each end, to measure off, at right angles, a distance of 300 feet each way, merely as assurance that he covers the

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entire thickness of his lode. Since the surface contours of rugged country will crook the outcrop of a dipping plane (such as we may imagine a vein to be) the laws were constructed to permit a claim being laid off with angles or bends in the boundaries so that the outcrop might be kept closely along the middle of the claim.

The above dimensions and area are the maximum permissible under the Federal laws. The Government does not say that claims may not be less in extent, anywhere, nor does it prevent states, counties or even mining districts from making further limitations. In most of the western mining states and territories that have applied the mining law, the full maximum is allowed; but in Colorado no claim is legal if it exceeds a width of 300 feet, while in four counties of the same state claims have been restricted in width to 150 feet. By legislative enactment, since September 1, 1911, claims in all counties of Colorado are permitted to be taken up 300 feet in width. The citizens or miners of any new district, in any state or territory,



A GILPIN COUNTY, COLORADO, SCENE.
Showing the Prize, Gunnell, Concrete, Gold Collar, and Eureka Mines.

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may elect to limit claims to any size less than the maximum granted by the statutes and such a decision will be recognized by courts as binding upon all comers. This is an example of the rights of custom in establishing common law. In all shapes and widths of lode claims, there is now the rigid restriction that the two end-lines must be laid off exactly parallel.

The laws of our country contemplate the right of any locator of a vein to follow such vein down upon its dip, even if it extends beyond vertical planes passed through the side boundaries. The vertical planes through the end-lines, however, may not lawfully be penetrated in the extraction of ore bodies. The application of this doctrine of "extra-lateral rights" has led to innumerable controversies that have crippled many worthy mining enterprises. The inevitable habit of different veins to intersect, branch, unite, and in many other ways to cause complications, has served no purpose but to delay operations, cause legal warfare and embitter neighbors. So unjust have been courts' decisions in interpreting

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the lax laws that various mining districts have taken unto themselves the prerogative of deciding for themselves what is justice to all concerned; and we therefore find that many "camps" have unwritten laws under which claimants are restrained in their underground operations, to the ground contained between vertical planes *through all boundaries*, whether end or side. This is obviously the only fair plan, and it is hoped that, whenever the legislators at Washington get time to give to the matter the attention it deserves, our nation will be favored with a revision of this and a number of other objectionable mining laws which have retarded the industry. Ours is the only country having laws permitting extra-lateral rights and, upon this score, we are criticized by all foreigners.

The Canadian government appears to leave the framing of mining laws to the several provincial governments. Ontario and Quebec have very good and simple laws relative to mining claims. In some respects the laws of the two provinces are similar. For example, in each province a claim must be laid out as a subdi-

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vision of the usual public survey and is normally 40 acres in extent. Again, no prospecting or locating may be done except by persons holding so-called miners' licenses or miners' certificates, which cost \$5 to \$10 per year. No extra-lateral rights are recognized.

In Ontario, a patent may be applied for any time within 3½ years of the date of certificate of record, and the land is purchased outright by the payment of \$3 per acre. The patent thus obtained conveys no rights to timber or water on the property. In Quebec, patents are never issued and mining claims are held by a sort of lease, as it were. A license to hold a mining claim costs a flat fee of \$10, plus an extra fee of one dollar per acre. At times, arrangements are made for holding and working mining property upon a 3 per cent royalty basis.

The Mexican laws permit the location of any number of claims by individuals. A locator is required to employ an expert (*perito*) to make a careful survey of his claims (*pertinencias*), which are taken up in rectangular form. Measurements are

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according to the metric system, and the unit of area is the *hectara*, which is the area of a square with 100-meter (328-feet) sides, and is equivalent to 2.471 acres. The government's sale price for mineral ground is 5 *pesos* (about \$2.50) per hectare, or approximately one dollar, United States money, per acre. The unit size of a claim is a hectare, and it thus comes about that the words *pertinencia* and *hectara* are used somewhat synonymously.

Under United States laws, the owner of agricultural land, if he has not committed perjury in perfecting his title, will hold all minerals which may be disclosed subsequently to the granting of his deed. The proof of false representations will rescind any such patent and the ground will revert to the Government and be again open to location.

In the surveying and laying off of mineral claims for patent purposes, the United States laws require the claimant to put the work into the hands of a mineral surveyor. Such a surveyor may usually be engaged in any mining district and he will hold a commission from the

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Department of the Interior authorizing him to do this sort of work. He will have passed certain examinations as to his capabilities and he will have filed bonds in the sum of \$5,000 for the faithful performance of his duties to both the Government and his client. He receives no compensation from the Government, and each claimant may make such terms with him as are equitable. He must hold no interest, directly or otherwise, in the property he surveys, nor is he permitted to file upon any mineral land. If he undertakes a case for a client his duties require him to survey the boundaries of every other mineral claim which may be contiguous to, or conflicting with, the one in question, and his maps must accurately show all such claims. His notes will contain sufficient data to accurately convey the exact location, the chief topographical features, the conflicts with all other locations, the position, and description of all mining improvements, and many other details which will be required in the final purchase of the land from the Government. The

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surveyor's fee will vary from \$50 to possibly \$200 for a single claim, much depending upon the nature of the survey, whether simple or difficult, and upon local financial conditions and competition.

After the filing of the mineral surveyor's notes and plats with the Surveyor-General, critical examination of the documents is made, and if they are found to conform with all requirements, the case is "approved" and it may then pass to the local land office of the district. Next begins a publication period of sixty days, during which opportunity is offered the public to enter objections to the issuance of a patent, either for reasons of conflict or because of fraud. If no such adverse proceedings are instituted, the patent will follow, in due time.

The ultimate expense of securing a patent to a claim of, say, the maximum area will not be less than \$225, and it may run as high as \$300 if in a region difficult to survey or if there are a good many conflicting surveys.

A mineral surveyor is prohibited from acting as attorney for the claimant in

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presenting his claims before the Land Office, so an attorney's fee must be added to the above rough estimates. As a matter of fact, although the surveyor does not nominally appear as the attorney, in many a case it is he who makes out all of the documents to be then signed by an attorney in fact. The laws are faulty in this respect. The lawyer recognizes this fact and he asks the surveyor to make out the many legal forms; for who is so fully cognizant of the property and the desires of the claimant as the surveyor who has become intimately acquainted with the premises, its workings, its desirable features and everything concerned with the adjustment of conflicts? It is to be expected that he could best protect the claimant's interests, and it is wrong to retire him at this very critical time prescribed by a foolish law. The fee of an additional man in the case is an unjust burden upon the client. Land Office officials have recognized this fact. They know that the best documents reaching their offices are those prepared by mineral surveyors.

VII

PLACERING.

Different writers hold the following slightly different definitions of a placer: One says, "a placer is a surface *accumulation* of minerals in the wash of streams and seas," while another writes that a placer is "a *place* where surface depositions *are washed* for valuable minerals, such as gold, tin, tungsten, gems, etc." One definition conveys no notion of the operations of mining, but is merely geological, while the other involves the thought of the recovery of values.

No matter how or where found, placers were all originally of surface deposition. They are now found in gulches, cañons, valleys, ocean and lake beaches, glacial drifts, and sometimes beneath eruptive flows. Such placers as occupy the courses of streams are spoken of as gulch, valley, bar, and bench placers. The meanings of the first three names are obvious. By a bench placer is understood a deposit

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that was originally the bed of a stream, but which, in the course of time, has been cut down, or through, in such a manner as to leave a shelf or bench of the "wash" hanging up some distance above the present base of the gulch or valley.

When such deposits that have been covered by lava flows are disclosed and worked, they go by the name of "buried placers." They are, by no means, uncommon, and typical "drift mines" of this sort are operated in California and New Zealand. They present the novelty of working alluvial deposits under cover of solid rocks, and they thus conform to one of the early definitions of a mine, as previously given. Since the workings of such subterranean placers are generally confined to an approximately horizontal zone, the mine passages, to a certain degree, resemble those of a coal mine.

Placer deposits, being of a secondary nature, the materials are not in the place nor form of the original components. The gravels and sands, together with the valuable contents, probably originally ex-

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isted in some solid forms such as rocks or massive minerals. The primary structures, in the course of ages and by atmospheric agencies, have been disintegrated and carried by gravity and flowing water to lower levels. The finer the decomposed material, the further it has been transported.

If the original rocks carried gold, the flakes of the metal, being of high specific gravity, would tend to settle to the bottom of the channels and to be carried shorter distances than would the lighter, non-metallic particles. The finer the gold, the more evenly will it be distributed in the bed of gravel. Likewise, placers near the heads of gulches, as a rule, carry coarser gold than those farther down stream.

The valuable materials found in placers must, of necessity, be those that possess the property of resisting corrosion and disintegration. The minerals and metals are, therefore, of a very permanent character.

Every find of "values" in a placer is unquestioned evidence that somewhere,

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above the present deposit, there originally existed primary depositions containing the valuable metals or minerals. The trail can frequently be traced back to them. These so-called "mother lodes" are not necessarily rich. In the case of gold, for instance, these original deposits of ore may not carry the metal in coarse enough particles to be visible and yet the placers may contain nuggets. There are numerous theories proposed to account for this observed phenomenon, but we will not discuss them here. The fact remains that nuggets have been actually produced artificially in flowing water under conditions similar to Nature's.

The methods of prospecting and working placer ground have undergone many improvements, but there are still many men practicing the primitive ways of a generation ago. The use of devices of simple construction and for operation by muscular effort is still familiar in many regions; and there are good miners who cling to such practice in the belief that it is the cheapest and truest way in which to ascertain the values of wash deposits.

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Also, there are many placers of limited areas and irregular shapes that cannot be well handled in any other manner.

With a "pan," a man can wash, in ten hours, not over one cubic yard of dirt; and to accomplish this amount of washing the ground must be very loose and favorable. An ordinary ten-hour day's work is about 100 pans. This is equivalent to about one-half of a cubic yard, which is the unit of volume in all placering operations. One may thus readily arrive at the cost of carrying on operations in this way. A cubic yard of ordinary placer dirt is the equivalent of less than two tons. A *batea* is the Mexican equivalent for the American iron gold pan. It is a sort of broad, conical, wooden bowl and its capacity is not equal to the pan.

A "rocker" or "cradle" is a trough on rockers somewhat like the old-fashioned child's cradle. In using it, a stream of water is caused to flow into the device which has been nearly filled with gravel and the miner gives it a rocking motion that causes the contents to classify or

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stratify according to the laws of specific gravity. The valuable particles, being the heaviest, will settle to the bottom, whence they may be subsequently removed. A "long tom" is an inclined, narrow box set stationary with a constant stream of water entering at the upper end. Gravel is also shoveled into the device at the same point. The process is more continuous than the preceding ones, the values accumulating at the bottom of the lower end, while the upper layers of gravel are carefully removed by skimming with shovels. The work will keep two men busy and the capacity is correspondingly greater. With a long tom, two men will ordinarily handle about five or six cubic yards in ten hours.

Whenever deposits of a broad area, with considerable and uniform depth, are thought to be valuable, it has become a practice to prove their value by "prospect drilling." This is a mechanical method and one form of apparatus employed is of the churn-drill type common throughout oil and coal regions. With these portable machines, holes are put

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down to bed-rock at intervals across the ground. As they are sunk, the holes are cased with iron pipes, the drillings are carefully saved and washed, and the values are estimated for each foot of descent. From the summation and averages obtained from all the holes, a very fair knowledge of the ground's worth can be obtained.

Intensive placering is now the order of things and the marvelous increase in the use of dredges attests the success which these "gold ships" have attained. It is very interesting to watch the operations of these huge boats loaded with ponderous machines, especially when they are installed in inland regions or up in high mountain gulches. Yet numbers of them are thus in steady use. Wherever suitable beds with a tolerably uniform size of boulders and gravel are found, dams are built to retain the flows of streams until ponds are created of sufficient size to contain and float the barges.

Continual improvements are being made in the construction of these mam-



DREDGES OF YUBA CONSOLIDATED GOLDFIELDS, HAMMONTON, CALIFORNIA.

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moth machines with a view to economy in operations that will result from greater capacities. All costs of placering are reckoned per cubic yard washed. Costs have been rapidly dropping during the past decade until now some companies, with extensive operations, are handling dirt at not to exceed three cents per cubic yard for excavating, washing, wasting the refuse, maintenance, repairs, labor, taxes, interest on investment, and the depreciation of equipment. Such figures will hold good only under very favorable natural conditions of ground and climate such as prevail in California; they have not been attained in the frigid regions of Alaska nor in the torrid South American interior. In view of the wonderful improvements brought forth by mechanical engineers, it is improper to deny that the future will bring still further reductions in placer costs. On the contrary, the signs are good for material reductions.

Dredges are very costly in their installation. They are usually designed to handle so many thousands of cubic yards per day. It has been stated, as a fair

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but rough rule, that "bucket" dredges will average, in initial cost, one dollar for every cubic yard the boats will handle per month. Thus, if a dredge of this type is built to treat fifty or seventy thousand cubic yards in a month, working steadily, the costs will be respectively \$50,000 or \$70,000. Other types of dredges, known as the "dipper" and the "suction," will cost less than the bucket type, but have not gained general usage.

"Hydraulicking" is extensively practiced. This term signifies the working of placer deposits by water which is conducted through flumes and pipe-lines and, by means of nozzles called "giants" or "monitors," is directed, in huge jets, against the banks of gravel. These banks or walls are thus torn down and, by the same water, the loosened, disintegrated materials are caused to flow into and through long, wooden, box-like troughs known as "sluices." The floors of these sluices are paved with ribs, cleats or other obstructions termed "rifles" whose function it is to retard and collect the heavy particles which may,

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later, during the process of cleaning up, be removed as the valuable product. The word "sluicing" is frequently used quite synonymously with hydraulicking.

Costs of this latter sort of placering are considerably higher than those of dredging; but there are many deposits not adapted to dredging operations that may be nicely worked by sluicing, so that there will always be a field for this scheme. Average costs are difficult to obtain since it happens that most of the companies now operating hydraulically are secretive in their accounts. More labor is entailed, more time is required, greater delay is occasioned in cleaning up, and the amount of water used is much greater. Where water is abundant, this last item need not be considered. It is well to remember that even a very large dredge, while requiring a continual and large flow of water through its devices, can still operate with just the water in which it floats, this water being pumped and used repeatedly; whereas, in the case of hydraulic mining, the water may be used but once and, conse-

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quently, there must be a large supply and at a good head or pressure.

But, in spite of these disparaging points, we find instances in which, under peculiarly favorable conditions, hydraulicking has been carried on at very low figures. E. B. Wilson says: "The yield of the gravel at North Bloomfield was 7.75 cents per cubic yard; the cost of mining, 4.1 cents per cubic yard. The yield per cubic yard of gravel at La Grange was 10.19 cents, the cost of mining, 6 cents. The costs of mining at these two mines would analyze about as follows: Labor, 60 per cent; supplies, 17 per cent; water, 13 per cent; office, 10 per cent. Ground carrying but 3.99 cents per cubic yard has been worked at a profit at the first mine. With such a small margin to work on, it is evident that skill and executive ability must be provided from the pipemen up." It is claimed that an Idaho mine was worked profitably with less than two cents value in the dirt, but this is to be regarded with some doubt.

There are large deposits in the arid



THE SNOWSTORM PLACER, FAIRPLAY, COLORADO.
A Typical Hydraulic Mine.

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portions of the globe where water for working is not obtainable. To meet such conditions, numerous inventions continue to be placed upon the market. These devices are all planned in such a way as to use very little or no water. If water is required at all, the machines are expected to use it repeatedly. The machines are built to effect the segregation of the precious contents gravitationally, electrostatically, pneumatically, and by amalgamation with mercury. It is too early to say how successful such devices will prove in commercial operations. Because some of them have not "made good" does not mean that genius will not yet cope with the situation; and we look into the future to see large operations efficiently and economically conducted by dry placer machinery. There are now no authentic figures obtainable upon this question of dry placering costs.

VIII

OPEN MINING.

Some mention has been already made of open mining. The greatest development of this sort of mining has come about since the application of the modern steam shovel to the excavation of ore. This practice was an American innovation and it is being adopted throughout the world wherever natural conditions will warrant.

Within the past few years, immense bodies of iron ore have been discovered in northern Minnesota and the adoption of these immense, mechanically operated shovels has worked such economies in the mining of this kind of ore that entirely new cost figures have been established and tonnages are being produced which, a few years ago, would have seemed unbelievable. There are about a dozen mines of this "open pit" type that have each produced over a million tons of ore per year in a season that must cease with

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the close of navigation on the Great Lakes. One mine has shipped over three million tons a season.

At the Utah Copper Company's mine in Bingham Cañon, Utah, a great deposit of low grade, copper-bearing eruptive rock is being handled upon a steep mountain-side by this same scheme. This ore averages a little less than two per cent. in copper, but so economical is the handling of it in such vast amounts that a neat profit is made above all mining, transportation and milling charges. When the red metal sells at thirteen cents per pound, the gross value of this ore is about \$5.20 per ton. This mine has maintained an output of ten thousand tons or more per day over long periods.

A famous gold mine in Queensland, Australia—the Mount Morgan—is also being worked by steam shovel methods. The deposit is here in the form of a small mountain and the operations are gradually razing this landmark to the level of the surrounding plains.

The mining of low-grade *gold* ores by open-pit methods has taken hold in Amer-

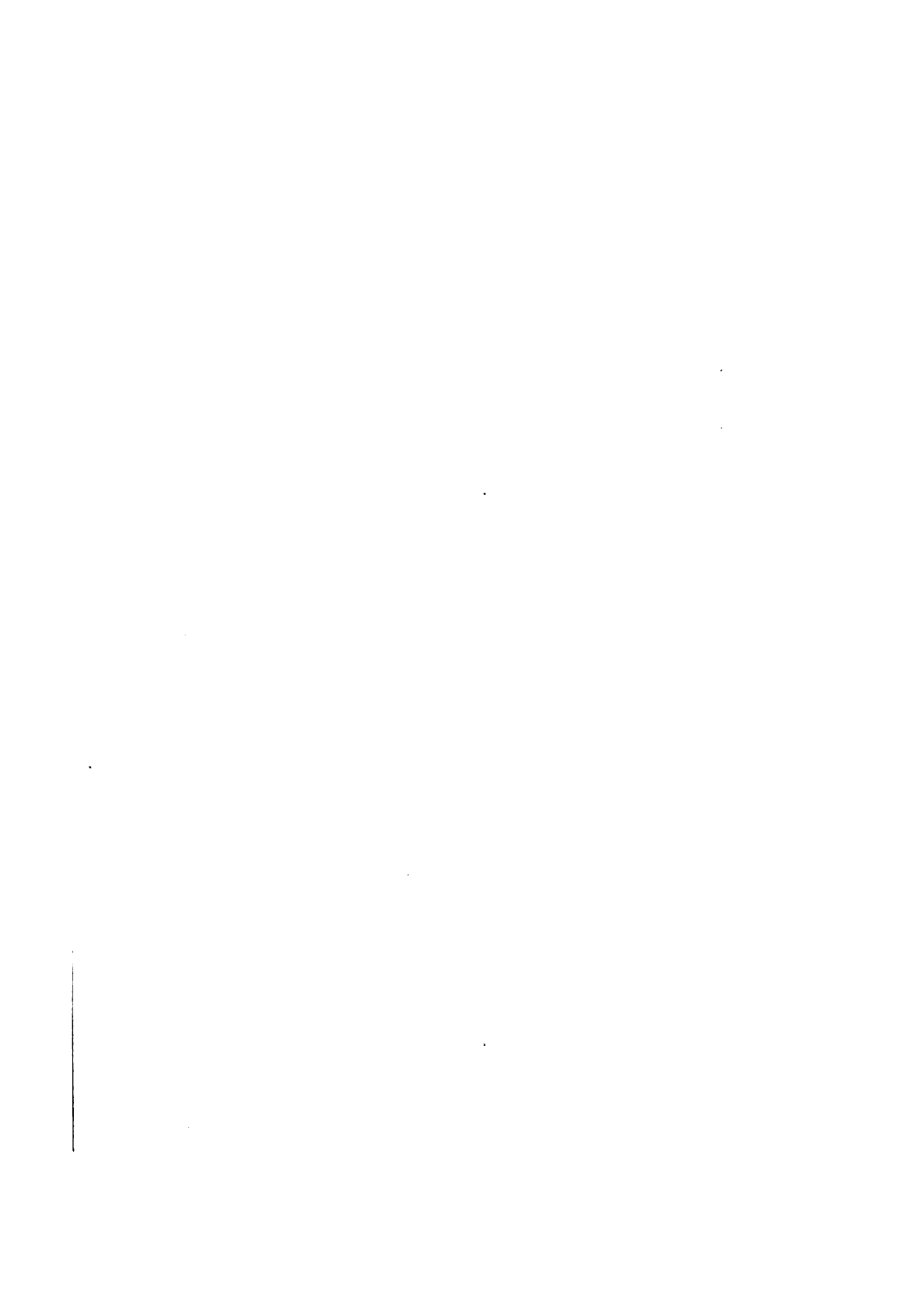
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ica, and an example of the practice may be found at the Wasp No. 2 mine in the Black Hills. According to published accounts of the operations of this company, all of the costs of mining and treating the ore amount to only \$1.02 per ton. The ore body is a bed of quartzite lying nearly flat, and averaging in the neighborhood of only \$2.50 per ton in gold, the only mineral of value. The recovery of this metal is at the rate of between 75 and 80 per cent. efficiency, or about \$2 from each ton. The net profit is therefore close to one dollar per ton. This very modern scheme of mining has been made possible through the recent advances made in the cyanidation of ore, and it is going to pave the way for many more such mining plants.

The Nevada Consolidated Copper Company has conducted vast mining operations "in the open" at Ely, Nevada, by the use of 95-ton shovels having a capacity of two and one-half cubic yards per dip. One shovel has handled as high as 2,800 cubic yards (the equivalent of about 5,500 tons) in nine hours; but this



STEAM SHOVELS AND CHURN DRILLS, COPPER FLAT, ELY, NEVADA.



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must be recognized as an exceptional run, and cannot be taken as an average. The ore has a thickness of about 200 feet and covers many acres. As in the majority of such properties, there is here a large amount of "overburden" to be removed and disposed of before the ore can be excavated. This process of uncovering the ore body by the removal of the overburden is called "stripping." The cost per ton of ore mined is said to average 55 cents.

In an open mine there must be maintained a system of continually changing tracks placed upon grades (sometimes rather steep) and with sharp curves. With multiple switches, numbers of small locomotives are kept busy pulling and pushing up and down the tracks with their strings of loaded cars and replacing the "loads" with "empties." When such operations are upon a mountain-side, a very beautiful panoramic view may be had from the opposite side of the gulch.

Generally, the ore material is disintegrated to some extent. In some cases, it

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will actually crumble down before the advance of a steam shovel. In other mines, it is necessary to drill large holes which are loaded and blasted.

It is becoming more and more important for the active mining man to post himself upon the methods and economies of this latter-day mining practice. The development of this open or surface mining has introduced entirely new economic ideas. With no costs for timbering of mine passages, for ventilation, or for hoisting, and with a very material decrease in manual labor per ton mined, immense masses of rocks are now really ore, although a few years ago they were nothing but lean, country rock.

In consequence of the success attained by the pioneers in this kind of mining, there has been created a demand for properties possessing large deposits of low grade ore that is workable on this intensive scale. Copper properties have been holding a prominent place recently and stockbrokers carry regular lists of "Porphyries," this nickname having been coined to cover the companies operating

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in the low grade porphyry ores of the Western United States. Not all of these porphyry companies will use surface mining methods. Some companies in the Globe District of Arizona have started extensive underground schemes for mining large tonnages very cheaply by "caving" methods.

IX

CONSIDERATIONS PRECEDING THE OPENING OF MINES.

The word "exploitation" is used by many mining men and engineers to signify a plan of so opening up ore deposits as to render the contents removable. The same persons use the word "mining" to mean the operations involved in the actual extraction of the ore exploited. It is sometimes difficult to draw any line between the meanings of these two words for, as handled by different men, with varying shades of intention, they are sometimes synonymous. Thus, if exploiting an underground mine, which carries ore right from the surface, means developing the mine in such a way as to provide for a large, steady production, it is difficult to see why the ore taken out in this process cannot be said to be "mined."

By "dead work" is usually meant that work of opening up a mine which will put

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or keep it in a producing condition but which does not supply any remuneration in the shape of ore (or coal). Again, as used by some men, there is little distinction between this work and exploitation. There may, however, be lines reasonably drawn between these three terms, and therefore the following definitions are proposed:

Dead work is such work as is necessary to develop an ore body, but it does not produce any ore. It may be prosecuted for drainage or ventilation purposes or for creating passage-ways for men and products.

Exploitation is also work performed in opening up or developing a property, but it does not contemplate the value of the extracted materials which may, or may not, be of any commercial importance. Indeed, much ore might be extracted during work which was carried on merely to define extents or boundaries of ore bodies. In this last supposition, the original sense of exploration is brought out and this should serve to fix the definition clearly in mind.

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Mining may be restricted to mean the methods and work involved in the profitable production of the mine's ore (or coal). The term would not be used to cover operations of shaft-sinking, tunneling, and the like, unless such work be in the valuable materials. Mining may be said to begin whenever there is produced an output upon which there is some profit. Exploitation may be in valuable ground. If so, we may say that mining is in progress during the exploitation. The driving of levels or drifts in an ore body—or of entries in a bed of coal—produces the valuable products of the mine, and we may, therefore, consider that mining is taking place.

The driving of a crosscut through barren rock to reach an ore body is dead work; but the driving of a drift or level in a vein is either exploitation or mining. Dead work produces *no* ore. Exploitation may, or may not, produce ore. Mining must produce ore.

Throughout all of the above and the following discussion of this chapter, the reader should bear in mind the point that

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the word "coal" may be substituted for the word "ore" without altering the substance of the definitions or the conclusions.

Before a mine is opened up, the economist-manager will consider many items. In the first place, care must be exercised in the *examination of the title* to the property. A mineral property may have passed through the most complicated kind of transfers of fractional interests in the title, just as is true with ordinary real estate. The abstract must be traced back clear to the issuance of patent from the Government, and then on back to the original location. With an undeveloped property (a prospect), this precaution is essential to estop any possible pretensions to ownership, by outside parties, in case the ground subsequently turns out to be exceptionally valuable. It has often been the case that no obstructions from any adverse claimants have been met until owners have, in good faith and at great expense, developed splendid mines. Then suits for possession or partial ownership have been instituted, sometimes with marked success for the plaintiffs. There

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are persons who make it a special line of business to examine titles to mining property, and it is economy for the average manager to employ such experienced men to attend to these matters.

Topographical considerations will hold a place in the study preceding the opening of a new mine. The nature of the surface of the property and the surrounding country will largely influence in the selection of the proper site for the mine's mouth. Neglect upon this point has been a common cause of failure in mining operations.

A mine opening must be away from all dangers of snow-slides, rock-slides, cloud-bursts and deluges from overflowing streams or breaking dams. It may make a difference in the mine's ventilation as to which direction the prevailing winds blow and therefore upon which side of a hill the mouth be opened.

Transportation facilities must be given due thought. If means are not already at hand, one must inquire into the feasibility of constructing some form of carrier; and here, again, will enter the question of the surface's contour. If a railroad is out

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of question, possibly an aerial tramway may be constructed. These modern conveyances stop at no obstacles of surface configuration and are dependent only upon the necessity of having the point of delivery lower in altitude than the point of loading at the mine. With some of the modern improvements in these installations, mine products are being transported up-hill as well as down-hill through the application of power. In mining regions, it is generally the case that the mines, themselves, are above the settlements in which are the railroads or treatment plants, so that the mine products will transport readily by the natural force of gravity.

Climate holds an important place in the economics of mining. The working of very rich pieces of ground may prove a losing proposition in some portions of the world where the climatic conditions are such as to render operations possible during only a very small portion of the year. Extremes of heat or cold, malaria or other pestilential obstacles, long rainy seasons with floods, and the hostility of

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native humans, beasts or insects have accounted for the abandonment of seemingly attractive mining projects.

The question of *labor* must be given due thought. It is true that the best miners on earth are Americans. We do not deny that many of our miners are of foreign birth, but the fact remains that they perform better and more intelligent service than do their fellow countrymen who have not been adopted into our country. Our men are in demand in the mining development of foreign countries. An American mine manager will always experience dissatisfaction while endeavoring to get, from natives in foreign parts, the same efficiency that he is accustomed to receive from the miners "at home." He may be paying a good deal less per capita for such labor, but he finds he is actually paying more per ton of output.

Even within a single country, there are notable differences in the worth of labor. The natives of some of the Mexican states are far preferable to those of other states. Within the United States, there may be discerned material differences between the

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efficiencies of the citizens of various sections, when it comes to mining. One cannot procure as competent miners in some of the agricultural states as in the typical mining states. This is but to be expected. For instance, there are deposits of lead ore in the "moonshine" regions of Kentucky which have never been successfully worked, and the real cause of failure, in the writer's belief, lies in the inability of superintendents to obtain real miners either in that region or from the outside. The residents will never become miners; outsiders will not enter for work under existing sociological conditions.

The question of *unionism* is sometimes held by managers as a deciding one when debating the opening of a mine. While there are those who will broadly denounce such organizations, there may be found other and just as successful mine operators who declare that the effects of union control over their miners are beneficial to their companies' interests. Probably the greatest objection to unionism raised by operators is that they resent the dictation that accompanies the inauguration

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of union rules in their mines. The owners and managers prefer to run their own business to suit themselves. Some managers are so imbued with this conviction of their own rights that they will refuse to open up mines or, if they are operating, they will close down their mines before they will submit to the demands made upon them by the union officials.

On the other hand, there are mine managers who prefer the presence of some central, labor-controlling body; for they believe that the men who belong to such a large federation or organization will, and do, have less complaint to make and therefore work more freely than is the case with the independent laborers. The argument is that these union men are satisfied because they feel that their interests are being looked after with a sort of attention that they, individually, could not give.

This is not a place to discuss the crimes that have been laid at the doors of both the labor organizations and the mine owners' associations. It is safe to assume that wrong has probably been done by

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both sides. But it is furthermore right to believe that most of the crimes were not authorized, nor recognized, by the officers or the majority of members of either side. Individual members must not be taken as averages of the membership in any kind of civil, social or political organization.

It seems entirely wrong that *politics* should enter into the considerations of a mine manager whose operations are apparently so apart from affairs of state; but the fact remains that there are places where mining operations cannot be carried on without the good will of certain officials of the state or national governments. It is not advisable to enter into any compromising terms to gain privileges for carrying on any legitimate business for there are other, better ways, generally, of attaining the justice that is deserved.

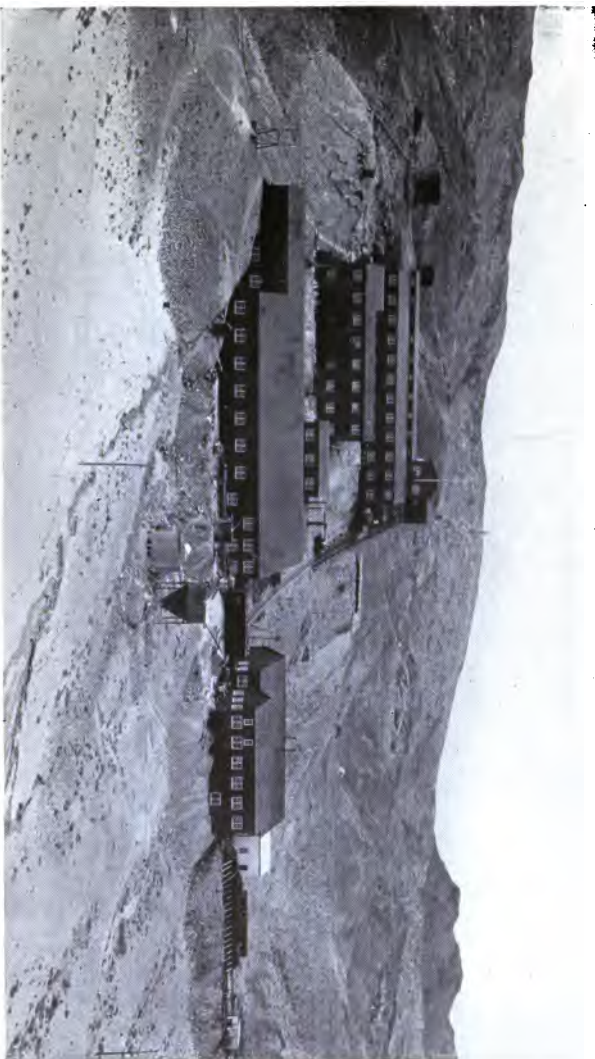
One must not omit to investigate the *sources of supply* for all the needs of a mine and its camp. There are many kinds of materials needed to keep a mine going. Fuel, machinery, timber, water, food for

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men and beasts, lumber, and all household furnishings and necessities must come from some markets or natural sources. It behooves the cautious manager to see that all these things may be had in ample amount and at figures which will not prove annihilating to his business.

In Utah, there are mines which have all their timbers framed in and shipped from the forests of Oregon, the sawing and framing being done before shipment to save on freight. The fir of Oregon is shipped to distant Australia for mining purposes. The arid camps of Nevada get their supplies of timber from the sister state, California. The Michigan mines are fortunate in being in a lumber region. Colorado's metal mines are more favored in the matter of timbers than are the coal mines of the same state. Most of the coal mines are upon the barren plains, while the metal mines are chiefly in the wooded mountains.

Water may be too scarce for the needs of a mine or its community. There may not be sufficient to supply boilers or a mill, or for the domestic purposes of the



MILL OF THE PITTSBURG-SILVER PEAK GOLD MINING CO., BLAIR, NEVADA.

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workers. On the other hand, water may be so abundant in the mine workings as to prove a deterrent factor in profitable operation. With shaft mines, having deep workings and low grades of ore, if water must be delivered mechanically, the costs for such drainage are frequently prohibitive of mining. Some mines, in arid regions, have been fortunate in striking such flows of underground water that it has been possible to operate mills right at the mines. In this way, the cost of water hoisting has been more than compensated in the milling benefits which, in turn, have decreased freights and treatment charges.

Machinery is usually purchased at centres of mining supplies and manufactures. San Francisco, Los Angeles, Salt Lake City, Denver and Chicago are the principal *rendezvous* in the West for mining men in need of machinery. Mexico City is, similarly, the outfitting point for the mines of southern Mexico. The United States holds the supremacy of the world in the matter of equipping mines and mills, large orders of American-made

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mining machinery being shipped to even the antipodes.

The nearer a property is to a depot of supplies, the less is bound to be the cost of getting goods onto the ground. It is this last item—the delivery of goods—that must be recognized as a very pertinent, and sometimes a critical, factor upon the cost side of mining accounts. Mines that are remote or in rugged countries are frequently dependent upon animal transportation. In some cases, machinery going to the mines must be so built that it may be taken apart into small portions suitable for loading upon the backs of horses or burros, or even, in the Andes, upon the frail llamas.

Operations, if planned to be conducted for a long term of years and therefore warranting the installation of large and expensive plants, should be based upon the holding of extensive ore-bearing ground. Here enters the notion of the *shape and size of a mining property*.

With some kinds of mining ground, the best form for the holdings would probably be a compact, approximately

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equilateral tract, covering a reasonably large acreage. This would be the case with ores that occur in sedimentary beds, for instance, where it is advisable to have the mining plant centrally located so as to work expeditiously the entire area. This would apply to a region like the Cripple Creek District, which contains innumerable veins running in all directions but displaying no outcrops.

In other instances, the most desirable shape might be long, narrow strips so laid off as to contain the strikes of persistent lodes or veins, as those of the wonderful Comstock Lode region. It is not acreage that counts here so much as lineal extent.

In the Transvaal, land is held in rectangular blocks. The first owners of the ground took it up for agricultural purposes. This same statement is also true of the mining properties in the Joplin District of Missouri and Kansas.

In the case of the South African properties, every company has definite boundaries to which operations may be planned. Hence it is possible for the management

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to so plant any mine as to operate it at a given rate for a predetermined life of the enterprise. The work is planned to maintain a certain output that will exhaust the ore bodies in just so many years, and all the equipment may thus be purchased with the forecast that it will serve its purpose and perform its economic share within the prescribed time.

This notion will be more readily understood when we consider the various types of ore bodies. With properties wherein there is no possible way of predicting the number, size, and worth of discoverable ore bodies, the life is wholly problematical and it is therefore difficult for a manager to decide how much he should expend in the initial equipment.

X

MINE OPENINGS.

In every new mining project, there is much to be considered concerning the expediency of opening up through shafts, inclines or adits. More attention has lately been given to this subject than formerly. There are very good reasons for the selection of any one of these kinds of mine openings.

The words shaft, incline, and tunnel have been handled with careless meanings by mining men. It is time that some definitions be accepted so that everybody will use these terms with the same meanings.

A shaft has loosely been any steep opening sunk through the ground. An incline—sometimes spoken of also as an incline shaft—has been taken to mean an opening resembling a shaft, but not very steep and not approaching verticality. Right here, there has been too much latitude

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of speech and it has entailed the necessity of many awkward explanations.

By a tunnel has been intended any (approximately) horizontal passageway driven from the natural surface. Objection to this use of the word rests in the strict definition of a tunnel, which states that it must have both ends open to the natural surface of the earth, as for example, an irrigation or a railroad tunnel. A level passageway which has but one end open to daylight is not properly spoken of as a tunnel. In mining practice, practically every horizontal opening of this nature is open at only one end, and it is an adit rather than a tunnel. If the precaution of speaking of it as a "mining tunnel" is observed, very well, for this may be taken to be an expression synonymous with adit. The latter term is, however, shorter and more correct.

For the sake of a uniform usage, the following definitions are proposed. Their use will conform with the usages of those well-informed persons who adhere to correct speech.

A *shaft* is a truly vertical mine passage

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which may, or may not, be sunk in or along an ore or a coal body.

An *incline* is any mine passage which occupies a sloping position and which may, or may not, maintain a uniform inclination throughout its length. It may be sunk along, or in, a pitching vein or seam and it may thus conform to the irregularities of the dip of such body. It is neither horizontal nor vertical. Such an inclined passage following a seam of coal is known as a *slope*.

It sometimes happens, especially in coal mining, that a sloping passageway is driven through barren rock either to get at known bodies by the shortest means or to establish uniform grades for tracks. In a strict sense, these are not inclines or slopes, for they do not even approximately follow, nor parallel, bodies of value. The miner's term for such an opening is *rock slope*.

An *adit* or *mining tunnel* is a horizontal opening driven from the surface. If it be driven along an ore body, as a vein, it is properly called a *vein adit*; if it is driven *across* barren country to intercept pre-

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sumed or known bodies, it is spoken of as a *crosscut adit*. All adits must be given a small amount of grade for drainage necessities.

Before getting underground we should consider what is required in the way of opening our mine; what is positively known about our body of coal or ore; and what conditions are liable to confront us later on. We must consider the type of ore body; character of material to be extracted; average thickness and hardness of the body; desired tonnage; power facilities; probable surface and underground drainage to be maintained; and dozens of other things which only the experienced man will think of and appreciate. The right kind of a manager will know that he cannot afford to overlook such points.

Every case involves different contingencies, and therefore extreme forethought must be given to the subject before deciding upon any particular kind of an opening into the ground for mining purposes. This remark does not apply to such openings as prospect drill-holes, openings

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which are not for mining purposes, but for exploitation. Assuming that sufficient data are known concerning the property to warrant the expenditures incident to the making of a mine, the question remains as to the best way of proceeding.

It is a well-established fact that it is much cheaper to drive an adit than to sink a shaft of equal transporting capacity. It is also cheaper to drive an adit than to sink an incline. If the topography is such that an adit can be driven into or beneath an ore body and thus expose it from a low elevation, the temptation is strong and along lines of good practice to do so. If the country is quite flat or nearly so, or, if the surface is such that, while rough, an adit of reasonable length cannot be driven to tap the valuable mineral and handle it economically, then it is good practice to decide upon a shaft mine.

An adit will not only be cheaper, foot for foot, than a shaft or incline, but, if given the proper, slight grade, it will afford a natural drainage outlet for all subsequent workings above its level. The

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cost of pumping, as already suggested, may be a considerable item and it may be a deciding factor in favor of an adit when this form of opening is possible.

Furthermore, an adit will obviate the installation and use of hoisting machinery, and thus there may be maintained a greater efficiency in the operating expense of the mine than would be possible with a shaft.

Again, it is a simpler and cheaper matter to maintain a mining tunnel in working shape than it is a shaft, particularly in bad ground. By the settling or "working" of the ground, a shaft may be thrown perhaps but slightly out of alignment and annoying interferences will be experienced in hoisting, especially when rapid and uninterrupted hoisting is necessary to maintain the desired output. While the same amount of disturbance does take place in an adit, it is an easy matter to readjust track grades while continuing regular haulage operations.

The timbers, in the case of either a shaft or an adit, will require occasional renewal, but the expense of such repairs is less in

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adits than in shafts or inclines, while the delay to other operations of mining, in the case of the adit, will be inappreciable.

Topography has been referred to above, but it must be again briefly mentioned. There are some places in which ore bodies extend to, or exist at, such depths that adits could not be projected to get beneath enough of the ore to warrant their construction. An adit mine is not a practicable thing in a flat country like Nevada or the Rand, but in the rough country of the San Juan it is the customary kind of a mine. In the very early days of Comstock Lode mining, shafts were sunk by each of the hundreds of companies. Before a great while, the advantages that would accrue from having a deep "tunnel" became evident, and the famous Sutro Tunnel, with its historic, checkered career, was driven. Although it loomed up like a gigantic undertaking for that period, the immense prospective or future value of it could not be denied.

The following relative advantages of the several types of mine mouths are in

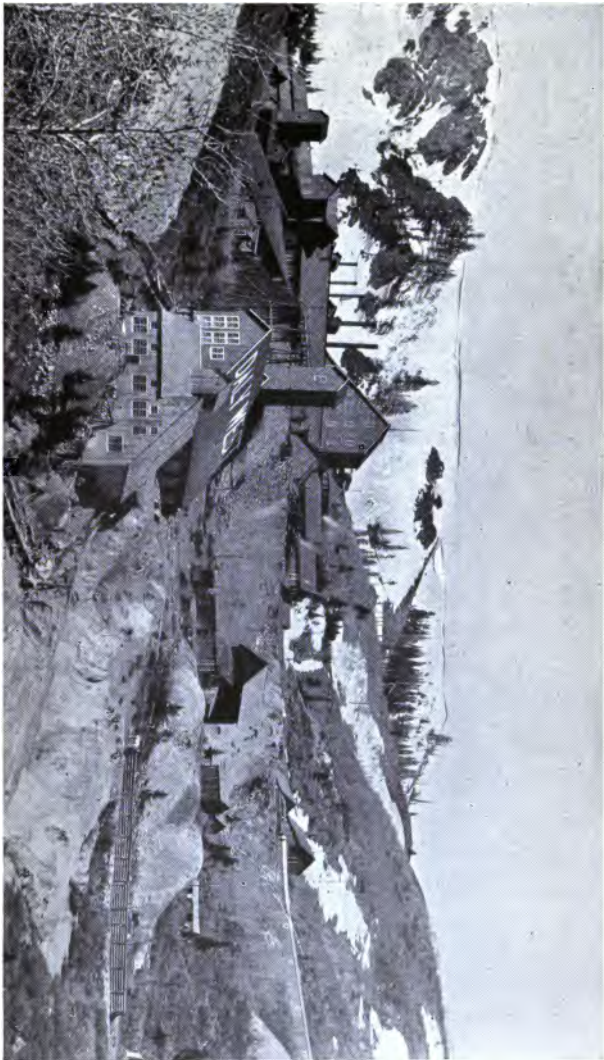
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addition to those already given and are worth consideration:

With an incline, the value of a tabular deposit is determined as work progresses; the course and dip of the body will be known at all depths along the incline; the body may be explored from the incline in both directions, simultaneously, with a resulting doubling of the development and production; all, or nearly all, the material removed is "vein stuff" and its value may repay the sinking expenses; there is no losing of the ore body unless a geological fault is met.

With a shaft, more rapid hoisting is possible than with an incline; the timbering labor is less than in the case of an incline, but greater than in the case of an adit; with ground containing ore bodies in irregular masses and at no uniform intervals, vertically or horizontally, stations and levels may be started wherever desirable; the crosscuts which are usually necessary to reach the bodies may disclose otherwise unknown bodies.

With a vein adit, the vein is prospected as work advances; the ore removed may



MILLS AND SHAFT HOUSE OF DALY WEST MINE, PARK CITY, UTAH.

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pay its own way, as it were; the drainage is automatic; ore is transportable from the mine by haulage rather than by hoisting; the ore in place is above the level and will handle itself to the outgoing passage by gravity.

With a crosscut adit, in addition to the last three advantages noted for the vein adit, there is bound to be exploration of the ground upon at least one side of the known body; there will generally be easier haulage because of the straighter track, since an adit driven along a vein will conform to the geological irregularities and the track is bound to be more or less crooked.

Without counting upon the doubtful success of the numerous propositions in tunneling machines, but judging only from past experiences, we may say that a shaft will cost about three times as much as a "tunnel" of equal transporting capacity. If the ground is wet, the discrepancy in first costs becomes much larger. In a remote region, with difficult transportation of machinery and fuel, it may be better to drive and use a long adit

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rather than a shallow shaft. An adit will transport more product than will a shaft of equal dimensions.

An adit may be driven to intercept a shaft and to serve as a sort of artificial surface, as it were, and thus save expenses in pumping and in hoisting up to the original collar of the shaft at the surface of the ground.

No matter how crooked an incline may be, it is possible to hoist ore in conveyances known as skips, although the hoisting may be necessarily somewhat slow. These same conveyances are useful for lowering and hoisting men, and the parody, "Men go down to the mine in skips," here finds its significance. The usual hoisting conveyances used in shafts are known as cages. They usually produce less friction than do incline skips. A skip in an incline must travel upon a track, while a cage, somewhat resembling a passenger elevator, has no wheels, but slides upon guides. However, an incline skip, because of the inclination of the passage, does not exert the same dead weight upon the cable and hoist-

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ing engine and hence these parts of the equipment may be made correspondingly lighter. Skips for shafts are similar to cages in their lack of wheels.

Complete estimates of probable future requirements should be made before a shaft is sunk. When it becomes necessary to enlarge a single-compartment shaft to one with two compartments, the expense has been found to exceed one-half the original cost of sinking; while, to convert a one-compartment shaft into a three-compartment shaft costs fully three-fourths of the original sinking expense. Approximately the same ratios of cost will hold in the case of enlarging inclines.

Character of ore sometimes influences the selection of the kind of passageway. Some high grade, brittle ores must not be dumped nor handled repeatedly, since values are lost in the "fines." Iron and copper ores will not probably be injured by any amount of dumping. Coal should be handled as few times as possible. In view of this fact, other things being equal, adopt that system that will injure the ore or coal the least.

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As a rule, workmen are safer in tunnels than in shafts, since there is little danger from objects falling any great distance. Tiny bits of rock have been known to kill men in shafts. On the other hand, there is less liability of injury from falls of large rocks in shafts than in adits. Roof falls are a very prolific source of mine accidents.

The workmen of neighboring mines will often be able to give much valuable information as to the proper procedure in opening a new property. For instance, water levels, amounts and kinds of gases that may be expected, the nature of the wall rocks, and other pertinent points may be learned by interviewing the men who are employed in adjacent mines. Still better information may be obtained by personal visits to the underground workings of the nearby mines. In this connection, one must not permit himself to be unduly influenced by the prejudices or hobbies of the neighboring operators or their employés if there is reason to suppose that such notions are contrary to good practice.

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Due consideration must always be given to the selection of some method of opening up what might be supposed will never amount to a great mine, so that, should subsequent disclosures exceed expectations, enlargement of the scale of operations can be advantageously effected. Always bear in mind that legitimate mining is just as much a commercial enterprise as is any other kind of business. The utmost concern for financial showings must be constantly borne in mind. Select a scale of operations consistent with the known—not the hoped-for—bodies of coal or ore; but have a certain feature of elasticity about the plans that may take care of future increase in business if found desirable. Do not “over-plant.” Never plant, at all, *prematurely*. It is better to postpone the installation of the equipment until some specific facts are available. Many companies have met defeat in the exhaustion of capital through the purchase and installation of elaborate plants which were never warranted.

After a mine is once opened and preparations have all been perfected to operate

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upon a certain scale of output, it is quite essential that exploitation and production be maintained without material fluctuations, if the greatest economy is to be attained. Exploitation, *i.e.*, development work, must be kept well in advance of actual mining operations to assure plenty of working space for the extraction of the normal output.

XI

TYPES OF ORE BODIES.

It has been necessary, a number of times in this discussion, heretofore, to make mention of kinds of ore bodies. It is well, at this time, to get some fixed ideas concerning the leading types of bodies of minerals which are extracted as ores.

Because of the laxity in type differentiation which has prevailed among miners and writers, the same geologists who have framed definitions of ore, have also defined the various types of ore bodies. The definitions, having been accepted by the leading mining geologists and engineers of the present day, it is well for us to fall into line and to agree with the authorities in such matters.

A *vein* is a *single, ore-bearing fissure*, generally, though not necessarily, with at least one well-defined wall.

When we run across a tabular-shaped deposit of ore that looks as though it may

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have been put into a pre-existing fissure or chasm, the chances are that it is a vein. But a vein must not be confounded with a dike. A dike is a filling that has been injected, while molten or fluid, into an open passageway or rupture across rocks, or into an opening which it created for itself. A little examination of the material should tell, to even the novice, whether or not the substance is of plutonic origin. The filling of a vein is not eruptive, at all. Veins have been filled from circulating aqueous solutions, by slow depositions, that have occupied very long periods.

A vein may be any thickness, since a fissure may have been opened to any width. Hence, a vein may be as thin as a sheet of paper, or it may be a hundred feet across. However, it is true that some wide veins have resulted by a sort of enlargement from original thin seams. Very few of the notable wide veins of the world are believed to have been created by the filling up of chasms originally as wide as the present ore bodies. But, in all cases of real veins, there were original fissures,

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fractures or crevices which acted as channels for circulating solutions that contained the materials which were left to make the vein matter.

A *lode* is an *assemblage of veins* so closely spaced that the ground between the veins becomes, in places, ore-bearing, and the entire width of the aggregation becomes an ore body.

A zone of sheeted rocks like schist or slate, if sufficiently mineralized to warrant mining, would be a lode. Sometimes, in certain districts, the earth's crust has been subjected to many approximately parallel, closely-spaced fractures, and by the subsequent filling of these cracks, with the accompanying corrosion of the walls and their replacement by ore, extraction of the entire mass of rocks across a considerable distance will be found to yield a profit. Any such body is a lode.

In the Cripple Creek District, the ground is criss-crossed in every direction by tiny fissures which have resulted from the contraction of the country rock, just as a bed of mud is fissured in the process of drying up after a rain. Wherever these

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fissures are found in aggregates that are closely spaced and in which a majority of the cracks have a general trend so that the whole assemblage can be readily worked as one mass, this whole body of fractured rock may be found worth mining and it will then constitute a lode. It may be mentioned here that the so-called ore of this district is not really ore according to the accepted definition. The true ore, the filling of these innumerable, tiny cracks, really constitutes but about five per cent. of the material that is shipped as ore, but which is principally the "country rock" broken down with the small volume of ore.

In *legal* phraseology, the word lode has come to include all sorts of ore bodies. When the word is thus used, in a legal sense, it should not be confused with the strictly technical meaning.

It has been the fashion for prospectors to dilate upon the fact that they have located "true fissure veins." This expression, formerly on the tongues of most mining men in districts possessing veins at all, is now obsolete and hence should

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be placed in the discard. There can be no such thing as an "untrue" vein nor an "untrue" fissure. Neither can there be any vein without a fissure. Therefore, if there is any vein, it must be a real or true vein. Accordingly, the verbiage is to be discouraged. The intention of a miner, in using this pet phrase, has been to convey the impression that his vein extended downward, indefinitely; there having arisen a notion that some veins are rather superficial and liable to "peter out" at slight depths, while others—the kind he invariably has located—persist both in size and value to extreme depths.

There are districts in which are found short fissures, generally confined to certain horizons in sedimentary rocks, such as the limestones of the great Mississippi Valley, from which are mined lead and zinc ores. These are called "gash veins." These are always readily recognized and there is not the slightest excuse for confusing them with the fissures which are common to other kinds of rock formations.

A *bed* or *blanket vein* is the term applied

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to any nearly flat deposit conforming to the bedding. Such a body of ore must be in a sedimentary series of rocks. Coal bodies are all of this type. Many bodies of iron ore are also of this type.

A *chimney* is an ore body which has not the tabular form of a vein but is rudely elliptical in outline, horizontally, and with a very considerable vertical extent. A *stock* is a similar body but it is of still greater irregularity of boundary.

These bodies are usually the filling of extinct volcanoes or geysers, and therefore they are presumed to extend to very great depths. The diamond mines of Kimberly, Africa, are of this type and the ore is a sort of hardened geyserite or mud in which are enclosed the precious gems. In Custer County, Colorado, the ore body of the Bassick Mine is a conglomerate of rounded boulders of all sizes cemented together, somewhat like concrete, by the materials which really carry the values. This mass occupies an ancient volcanic neck or throat of a geyser, probably the latter. The main portion of the Cripple Creek District is

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the crater of a great prehistoric volcano. It might be called a great chimney, but custom seems to limit the use of the word chimney to a smaller body such as might be included in a single mining property.

A *mass* is a deposit whose irregularity of shape is so great that it cannot be recognized as belonging to any of the types already mentioned. Masses conform to no rules as to shape or size. They are usually the result of a chemical dissolving of the original barren rocks with a simultaneous or subsequent substitution of valuable materials. There are many instances of ores that have been deposited, molecule by molecule, replacing equal volumes of the previous rock, much upon the order of the petrification of wood. Again, there are immense masses which are believed to have accumulated in caves already dissolved out of the containing rocks.

While recent geological study of the districts in which such ore bodies abound have disclosed numerous facts about their occurrence, there still remains much conjecture concerning their origins, and we

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may still believe that they do not conform to any rules as to regularity or size. The ore bodies of Leadville are of this type, and they may be described by the homely similes that they are as like and as unlike, and their occurrences are about as regular, as potatoes in a hill. The potato-tops give the farmer a suggestion as to where to dig. So, also, do certain geological relations guide the miner. And yet a shaft may be sunk hundreds of feet down among masses and not happen to penetrate a single one.

There are numerous recognized types of ore body not enumerated here; but it is sufficient for the average layman in mining matters to understand these few distinct types and to believe that all other types are rarities, and are, as a general thing, but intermediate forms of those defined.



Shaft No. 3, TAMARACK MINING COMPANY, CALUMET,
MICHIGAN.



SMELTERY OF THE BALAKLALA CONSOLIDATED COPPER CO.,
CORAM, CALIFORNIA.

XII

THE QUESTIONS OF DEPTH AND GRADES OF ORE.

The prevailing belief of a few years ago that ore bodies always improve with depth has been discredited. Not a single mining geologist will longer maintain such a notion. The evidence of many thousands of mines has refuted this older belief and it has been proven that quite the opposite view is the correct one concerning changes of value with depth. Values, instead of getting better, do actually, in the majority of cases, grow poorer as depth is gained.

President C. R. Van Hise, of the University of Wisconsin, was among the early expounders of the newer theories to account for this fact. The writer heard him state, years ago, before a scientific gathering (which, at that time, was not quite ready to agree with him), that if he were given his choice, he would much prefer to own the upper thousand feet of the earth's crust than all the rest of the

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globe. In this remark, he was referring only to mineral values, of course.

This belief that the best values are to be found not far from the surface has since become popular, for it is based upon proven facts. It is not claimed that values are never mined below an elevation that is a thousand feet from the surface. There are many mines, and great ones, too, that are operating at depths greatly exceeding this distance; but in these same mines there will be found valid reasons for not applying the general statement to their particular cases. For instance, the great copper mines of the Keweenaw Peninsula are productive at depths of a mile or more from the surface; but we believe that here the ore must have been originally deposited at, or near, the surface, that it was then overlain with rock strata; and subsequently steeply tilted by earth movements which carried some of the ore bodies down to the depths where they are now found.

The "reefs" or bankets of the Rand are so termed because these ore bodies were undoubtedly ancient coast beaches

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or sea placers. The gravel, sand, and gold particles were cemented together into a conglomerate, then covered with many later sedimentaries, and finally the continent of Africa was so raised or altered in some manner as to bring these gold deposits into their present inland and tilted positions.

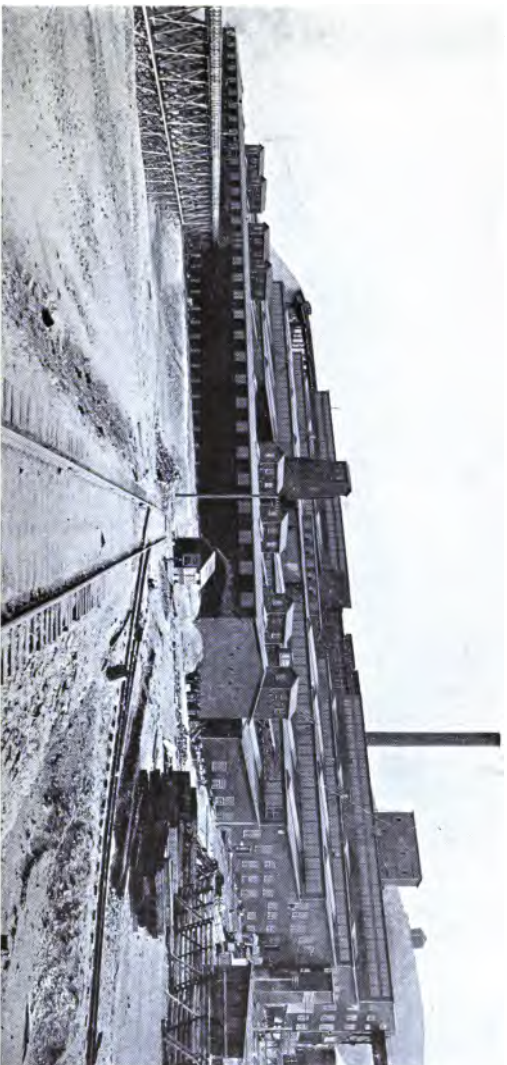
In veins or lodes, it is not supposed that ore-making minerals could have been precipitated from solutions travelling either upward or downward and obeying chemical laws if the depth were sufficient to furnish great temperature or high rock and hydrostatic pressures. Therefore minerals which were deposited from aqueous solutions rising from depths, for example, must have retained their dissolved condition until they ascended to horizons in which both pressure and temperature were low enough to permit the precipitation and crystallization that create ores. Contrarily, descending solutions must have given off their contents before reaching the deep zones of heat and pressure, or not at all.

It is a quite common phenomenon to

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observe that the richest *gold* ore in a mine is found close to the surface, if not actually at "grass roots." The explanation is simple. The gold, being the most stable of the aggregate of minerals composing the original ore, has the better resisted the corrosive attacks of atmospheric agencies and has remained nearly intact, while its associated minerals have been dissolved or altered and carried away. The same amount of gold remaining with a diminished quantity of the worthless, non-metallic minerals—the "gangue"—inevitably renders the ore richer per unit of weight (such as a ton), although per unit of volume the value remains constant, or nearly so, so far as the gold is concerned.

But with other kinds of ore, as, for example, copper, the best grades are found, not close to the surface but some two hundred or more feet down. The explanation is that the minerals of copper are considerably more soluble than the ordinary gangues and therefore the weathering and oxidation that takes place in the upper horizons of ore bodies will dis-



CONCENTRATOR DIVISION, WASHOE REDUCTION WORKS OF THE ANACONDA COPPER MINING CO.,
ANACONDA, MONTANA.
Largest Copper Works in the World.

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solve out the cupriferous compounds and thus deplete the superficial ore. But, by the flowing of the copper solutions to a lower zone, there occur certain reactions that reprecipitate the salts of copper upon compounds of the metal already formed and we have instances of the phenomenon known as "secondary enrichment."

It was this very process that effected the changes in the character of the ore in the famous Anaconda Mine, previously mentioned (page 44). The locator's discovery was upon an outcrop rich in silver. Probably the original compounds of the vein were of both silver and copper. The silver was more stable against dissolution than was the copper, with the result that the base metal was removed more rapidly and completely than was the precious metal. The upper portion of the vein was therefore left rich in silver, and low in copper. But, as depth of mining increased, there was found a gradual diminution of the silver content with a simultaneous increase in the copper. The mines of Butte have become known as

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copper mines, and the wonderful records they have made are ample testimony to the fact that the change in the prevailing metallic values has not wrought serious havoc in the mining industry of the district.

Regarding the probability of veins persisting to great depths, there is this thought suggested by J. E. Spurr: "Owing to the pressure exerted by gravity, it is doubtless more difficult for a fissure to stay open in depth than near the surface. The tendency is to press the sides together. At a certain depth, it is probably the case that the pressure and the plasticity resulting from this, together with the increase in heat, makes it impossible for fissures, fractures or any openings to exist."

There are still many persons who are reluctant to let go of the cherished notion about the improvement of ores with depth. But there is no economy in deceiving one's self, and the wise thing to do is to accept the truths as they are daily proven. It may be worth while to again refer to the wonderful

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Camp Bird Mine. This mine was discovered in its true worth years after it had been abandoned by early prospectors because it lacked showy, base-metal minerals. However, since its true merit has been recognized, it has maintained large and remarkably rich annual outputs. As values were beginning to show a material decrease, about five years ago, an experienced mining engineer of recognized standing was engaged to give advice concerning the future exploitation of the property. After exhaustive investigation of the ground, and in the face of adverse opinions, he recommended the discontinuance of further development in depth. At the same time, however, he advised the exploitation of the ground laterally or along the strike of the very persistent vein. His advice was followed and the company's stockholders had reason to be advocates of the new theory; for a very reasonable amount of horizontal development work opened up vast stores of rich gold ore.

And yet, notwithstanding this disquieting feature that seems to apply to mining,

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there is comfort to be found in the consideration of the exceptional cases. Every man may hope that when he locates a new mine he is taking possession of a property that will have as extensive ore bodies as those that have been proven to exist in the lead-silver mines of Laurium, Greece, the quicksilver mines of Spain, or the copper and tin mines of Cornwall. These mines are in lodes which have persisted and have been mineralized to comparatively great depths, so that their bottoms have not been reached.

There is a modern idea that has taken root in the minds of mining men of the last generation to the effect that the mines with rich ore are not necessarily the ones with big profits. There are many men looking for investments in mines whose contents are of low grade but in large bodies readily worked. If a mine with rich ore can be found and the ore abounds in such liberal amounts as to warrant the inauguration of a company with the essential working equipment, such a proposition will naturally not be turned down. However, the faith of some men is placed

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in those mines that may be operated upon very large scales for long periods even if the profit per ton be very small. With a large plant, the unit of expense, *i.e.*, the cost of mining per ton, is less than with a small mine. With the assurance of regular outputs of ore of a reasonably uniform grade, the milling equipment can be planned to handle a mine's product to the greatest advantage. The Alaska-Treadwell Mine, on Douglas Island, is an instance of a splendid property that has been continuously operated for about a third of a century. The ore is low grade in gold but immense dividends have been declared because the ore body, a tremendous mass of eruptive rock, has lain in such a position that the owners found it possible to excavate the stuff, to a great extent, by open-pit methods, although not by using steam shovels. The ore is treated in a vast mill contiguous to the mine.

The Homestake, another gold mine, has an ore body quite dissimilar geologically from, but of dimensions approximating those of, the Treadwell. It is a great

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body of mineralized, crushed shales, standing steeply in the shape of a lode and carrying about \$3.75 per ton. It has been followed down considerably over one thousand feet and although the grade has dropped somewhat with depth, there are known to still be millions of tons in reserve. According to estimates, the mine has enough positive ore in reserve to keep the mill running at the rate of 4,000 tons per day for several years even if no more ore were to be opened up. This ore nets but 53 cents per ton above all mining and milling expenses; but a little arithmetic will show that this mine is worth twice as much as the mine that is producing, with more or less regularity, an average daily output of, say, forty tons of high grade ore upon which there is a net gain of \$25 per ton, a figure that is rather high for the average of so-called "high grade" mines.

We must, therefore, decide that it is always wise to think twice before condemning a mine because its grade of product is low. It is only recently and by virtue of marked improvements in

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metallurgical processes that many bodies of mineral have become "ore." Hence it is but natural that many of the older miners fail to grasp the possibilities that lie in such deposits.

What is the line of value separating a low grade from a high grade of precious metal ore? There is no uniform practice along this line. One will notice that ores are nowadays spoken of as high grade that, before the practice of mining these described meagre deposits, were reckoned as low grade. This fact is due to two reasons, viz., the cheapening of metallurgical operations, and the greater respect that is entertained for ores of low metallic content. The Esperanza Mine, in Mexico, is called a high-grade gold mine. Its ore has averaged about \$33 per ton and the profit therefrom about \$19. The Oroya-Brownhill Mine, in western Australia, has had ore that carried a value of about \$22 per ton and from it a profit of about \$15 per ton was made. In the Cripple Creek District, ores that run above \$30 per ton are considered high grade. This means that

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the average rich ore shipments of the district have a gold content of about $1\frac{1}{2}$ ounces per ton. The expenses of mining, freight, and treatment will probably total close to one-half the gross value, or about \$15 per ton.

When one speaks of \$30 or \$40 ore as rich or high grade, it is not to be inferred that there is no ore in the shipments which is not worth a great deal more than this amount per ton. Such lots of ore will, no doubt, contain a great many chunks that would assay many times the average value. Such selected materials would not, however, be samples; they would be what are called "specimens." The specimen has its place in mine economic discussions because it furnishes the basis of operations for the ubiquitous "high grader" with which nearly every new and rich mining camp must contend.

Some writers claim that the high grader is a product of modern conditions; but we find that he has existed for such a long time that he was given mention by the Scotch historian and scientist Andrew

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Ure, who wrote of the precautions that were exercised in working the graphite mines of England, a century ago, to prevent the pilfering of even this comparatively low-grade material. Even the ignorant African natives of today cannot be trusted to wear clothing while working in the diamond mines. No, the cause of high grading is the innate greed of human beings and it has existed from prehistoric time and among all peoples.

In this discussion as to grades of ore, the question may arise as to what might be reasonably considered the most attractive kind of a mining proposition. This is too knotty a query to be answered in a few words. There are so many different phases that must be given due weight. Every mine is a problem in itself. The Minnesota mines afford the best examples of profitable iron mining. Under the classification of underground, tabular deposits such as veins or lodes, no matter in what metals their values are found, Mr. T. A. Rickard believes that the ideal mine would be one carrying ore worth

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\$10 per ton, in a body five feet thick, with costs not exceeding \$5 per ton, and so mined as to keep one million tons continually in reserve. According to these restrictions, he thinks the Robinson Mine, of Johannesburg, will about fill the bill as an ideal *gold* mine. It has a deposit of about the right thickness to avoid excessive timbering expense and this ore body is in such a vast, continuous sheet that its superintendent can depend upon maintaining a systematic development that will assure a constant supply of ore to the immense mill for ten or twelve years in advance. This same ore averages about fourteen pennyweights (approximately \$14) per ton and upon this there is assured a profit of over five dollars per ton.

XIII

VALUATION OF MINING PROPERTY.

Whenever a piece of mining property is to change hands, it is the proper procedure to employ an expert engineer to investigate the ground and the improvements and so arrive at some estimate concerning its intrinsic value. Nobody is infallible and it is a trite saying that "nobody can see into a mine farther than the last drill hole." But there is a great difference in the reliabilities of reports made by trained and by untrained men. A self-styled "expert" of the type which is so abundant in every new mining centre and about cities frequented by mining investors will probably not be able to comprehend anything beyond his vision; but the mining geologist and engineer—the man who has devoted the better part of his life to study and experience along these lines—will be able to reach conclusions upon which much reliance may

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be placed. This fact has come to be recognized by the men who exercise business judgment in their mining investments.

The sampling of mines has been studied and improved upon by succeeding engineers, until one may say that it is conducted along strictly scientific lines. The old method of taking a sample of a mine by scratching ore from the sides of a shaft from top to bottom and letting the collected material at the bottom represent a fair average of the ore body, has been relegated to its proper place in the evolution of mine valuation.

Without entering into a description of the methods now employed by the best examiners of mines, let it be said that every scientific precaution is taken to obtain representative portions of the ore bodies, at such intervals as seem best in each particular case; that measurements and assays are made for each and every sample taken and not for the aggregate of all the samples; that no opportunity is allowed unscrupulous persons to vitiate results in any manner; that a professional

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engineer will not hold nor acquire, in any way, an interest in any proposition which he examines; and that the report of a reputable engineer is equally acceptable to the seller and to the purchaser, no matter for whom the work is done.

Much discussion has prevailed as to the best means of estimating the amount and the value of ore in unbroken reserves. Associated with these beneficial disputes, there has been a further controversy as to the correct classification for reserves of unbroken ore. It is now conceded among mining men and engineers to be improper to longer make use of the meaningless but tongue-worn expression "ore in sight" as signifying any known or unknown volumes of ore in the ground. The only ore in sight is that which has been hoisted or which has been broken and stored underground. Well-known engineers have proposed the following expressions:

To denote the contents of ore bodies which have been exposed on four sides, we may say *ore blocked out*, *positive ore* or *ore developed*; for bodies exposed upon

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three sides, it is considered correct to describe the contents as *ore partly blocked*; for such bodies as are proved upon two sides only, the terms *ore faces*, *ore developing* or *probable ore* are appropriate; while in speaking of all ore that may be expected or suspected, but which is beyond the last exposures, we may use the expressions *ore expectant* and *possible ore*.

When it comes to the question of placing a value upon an undeveloped property—one in which there is little, or no, development work or exploitation—it takes more than the ability of the common “expert” of the curbstone variety to arrive at any dependable figures. Without any exposures, except those that may have been produced by Nature, and perhaps with no guidance from facts that might be obtainable were there adjoining mines, one might suppose that the whole matter would resolve itself into mysticism. Right here is where the trained man best shows his ability.

The greatest error of the usual investor in mining schemes is to rely upon either no report at all or upon a worthless one

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furnished by an impostor. *In no sort of a mining proposition is a reliable report so essential as when one is contemplating the purchase of a "prospect."* Successful engineers, whose predictions concerning such properties have come true, are sometimes complimented (?) by being accused of possessing intuition or prophetic vision. Call this ability what we will, we must admit that *education and training* give certain qualifications that will enable a man to arrive at conclusions which, in the majority of cases, will be found to wear.

XIV

THE MINE PROMOTER.

With the thought that has justly been given to the place occupied (or that should be occupied) in the world's financial and economic affairs by legitimate mining, there has developed a well-founded stigma upon the operations of a class of persons who have styled themselves by what was formerly considered a worthy title, that of "promoters." Since men have found that it is as possible to go into a mining deal with the same chances for success as attach to any other line of investment; since it has been proved that real, worthy mining property does not require the exertions of many middlemen to obtain capital for its development; and since it has usually turned out that these "promoters" have handed the hot end of deals to their investors, it is not to be wondered that some sort of a brand would attach itself to the men who are not in the business to benefit the industry of

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mining in the least, but really for the selfish gains which they can pocket at the expense of the industry.

These men are legion. The mails are laden with their seductive letters and "literature." Brokerage firms are numbered among these leeches on legitimate mining. Charlatans appear almost daily upon mining scenes. The men who engage in these deplorable practices are not from any one walk in life: they spring up from various branches of our social structure. The general public has learned that a very prominent Boston magnate will not scruple to promote a mining property even though it lacks the merit essential in attracting the conservative capitalist. Thousands of people of small means throughout the United States and Canada have been recipients of nicely worded and familiarly-addressed letters signed by the son of a famous American author. This son, himself a writer of some repute, presumed to speak to his "friends" concerning a mining property which he promoted and into which he was glad to allow them to get with him

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“on the ground floor.” He frankly stated that he was not offering such privileges to the big capitalists. He inwardly knew that such men do not require holdings in the Cobalt or any other region. Through the splendid work carried on by the Government postal authorities many of these frauds have been exposed and the perpetrators brought to justice. In January, 1912, the above-mentioned author, together with a number of his ilk, were brought before the Federal Grand Jury, and found guilty.

It is not the men of great capital who are induced, as a rule, into the deals of the “promoter.” It is usually the common people, the persons of small means who have saved up a little spare money from which they hope to realize competencies for rainy days—a class of beings inexperienced in investments—who become the dupes of the promoter.

There have been notable exceptions to the statement that capitalists do not yield to the seductions of these men, but recurrences are liable to be few. The great business man is fortified by experience against

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forms of treachery and he is, therefore, not so susceptible to the allurements of any "promotion," be it mining or otherwise.

If one investigates these advertised mining "promotions," he will often find that the money paid in by the small investors purchases a very small portion only of the capitalization. The men who conceived the scheme of "promoting" a concern have carefully arranged to hold a majority of the stock, so that should there, by any chance, prove to be a mine, they are the ones who will reap the greatest benefits. Further, it often transpires that the contributions of cash that purchase the small interests do not perform the function of development for which the stock was ostensibly put upon the market. Perhaps somebody has a desire to get rich quickly. The operations of such frauds are so obscured and so complex to the average individual that sufficient evidence can seldom be procured to prove any violation of law.

A witty newspaper paragrapher once remarked that out in Nevada the old adage "Death loves a shining mark"

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was changed to "Death loves a mining shark." It would seem, however, that if Death were to love the person bearing the odious, well-understood title of "shark" enough to claim him early, the business of mining would be materially benefited. The post-office officials of the United States are to be commended for their efforts at curbing the despicable operations of these fakirs. Occasionally the papers come out with the news that a firm's offices have been raided and their business stopped. These news items fall as awakeners upon the hundreds of gullible, middle-class persons all over the country who are known to actually force their cash remittances upon these fraudulent operators, much upon the plan of a department store's supposed bargain sale.

In spite of the "bad name" that has been attached to the persons engaged in starting up enterprises, there is a real need for more activity in the matter of inaugurating real, legitimate mining enterprises. Persons who devote their brains and energies in the direction of furthering worthy mining propositions do really

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“promote” the interests of such companies. What shall such persons be called if not “promoters”? There does not seem to be any other word that expresses the occupation of such persons. The real solution of this dilemma in which the honest men engaged in such work find themselves placed is to denounce, forcefully, the charlatan as being not a real promoter but a gross misrepresentation of one.

Let us, therefore, remove the odium from this title and give our approbation to those persons who are earnestly endeavoring, by honest means, to place mining enterprises upon strictly business-like footings. The mining industry needs promotion and promoters.

XV

INCORPORATION AND CAPITALIZATION.

Let us consider the legitimate financing of a new or a reorganized, worthy, mining proposition. It is the universal custom to own and work a mine under the laws that govern a corporation and, for this reason, the mining man of the day is familiar with the practices of incorporating.

It is something of a question at the start to decide what is a fair price to fix upon a property as a whole—that is, to decide what the capitalization should be. There is no rule to be followed in this matter. Some organizers will decide to capitalize at what is expected will be the value of the property after some time. Other men will stick to the idea that it is the proper thing to capitalize for what the property will invoice at the time. The higher the capital stock, the greater number of shares there are for sale, usually. With a conservative capitalization,

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there may be fewer shares for sale, but each share is worth correspondingly more and the chances are much better for an advance in the price per share whenever the mine becomes productive. There are investors who will carefully investigate this feature and will shun any mining stock which has any appearance of over-capitalization. It would be well if all investors were to follow this precaution.

But what about the price at which to capitalize a prospect? By a prospect we here mean a property that has been favorably reported upon as worthy of development but in which, up to date, there is little, if any, showing of values or reserves. The engineer's report has recommended the property as containing the possibilities of a mine. How much is it worth? Can he or can anybody even roughly estimate the sum? An engineer frequently does fix the sale-purchase price of a property, but it is not so usual for him to decide upon a valuation for capitalization. A very good guess may be made, perhaps, if there are similar and neighboring properties which have been developed.

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Assuming a prospect that has been reliably reported to the owners as possessing the earmarks of a mine and as warranting expenditures for exploitation, upon what basis should a company be capitalized? If the owners of the property have capital, the chances are that they will not care to share their holdings with other parties. But very frequently worthy "prospects" are held by men of no means, and in order to develop their mines the owners feel the necessity of coöperation with parties who can furnish working funds. In every such instance, there will arise this debate as to the proper basis of capitalization.

There is no human means of arriving at a *close* valuation of any prospect, so it becomes a matter of pure judgment as to future probabilities and the possibility of placing the stock at the most advantageous price. A company will, therefore, be stocked for some round number of shares, say 100,000, upon which some empirical par valuation, say \$1, is placed per share. This is not to be understood as stating nor assuming that the property

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~~has a present valuation equalling the par of the entire capitalization. Who would assert that any mere prospect ever had such a value as \$100,000? No, it is not the intention of the organizers to claim that the ground is worth the par valuation; but some start must be made and so, in the absence of something precise, round numbers are made to do service.~~

Stock is then offered at figures much below the par valuation and in such quantities as will maintain sufficient capital in the treasury of the new concern to get the property's exploitation under way and to so sustain it as to make the prospect grow into a mine.

~~If shares are offered at 10 cents, it does not mean that a prospect is worth even that valuation. It does mean (we are considering now only the operations of honest concerns) that the men who are managing affairs believe that the sale of so many shares at ten cents each will furnish adequate means for the development and equipment of the mine. Therefore, there is a prospective valuation placed upon all such enterprises.~~

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Is an investment in such a company to be considered as gambling? If there have been sound assurances from reliable examiners concerning the likelihood of the ground carrying the essentials of a mine and the only uncertain element is the ultimate magnitude of the mine, then we might say that the investment is not a gamble at all, since there is no chance to lose. The purchase of such stock is a very sane investment and there is no telling what the returns may reach.

When incorporating a new company, it has become the fashion for the owners of the ground to exchange their titles for certain specified fractional interests in the company. This is effected usually by going through the formality of having the owners sell their holdings outright for the entire issue of the capital stock. Then, according to prearranged agreements, these owners donate to the treasury of the company a portion of this capital stock to be henceforth termed "treasury stock." The first step makes the capital stock "fully paid for," since it has been accepted in full payment for

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the property. The second step supplies the company with the necessary means for raising funds to develop.

There can be no reasonable objection to this practice. But there is much criticism of the usual apportionment of the owners' and the treasury stock. It is agreed that the incorporators are, as a rule, greedy in this respect, since they generally issue more than 50 per cent. (and frequently 60 per cent.) of the capital stock to themselves and expect to float the project to success upon the money derivable from the sale of the balance or treasury stock.

Is a mere prospect, even under the best natural conditions, plus the effort incidental to the organization of a mining company, worth one-half or more of a producing mine? During an extended experience in the business of converting discoveries into patented claims and prospects into mines, the writer has found that *there is never an owner who is willing to sell a developed mine for twice the price he had set upon the original prospect.* The valuation of his holdings goes up by

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greater multiples than mere doubling or even trebling and it is a rare thing to find a man willing to sell out a proved mine at less than ten times the prevailing valuation that would have been placed upon the same piece of property before its development.

Hence, there is no propriety in the act of self-appropriating half the capital stock by the organizers. Investors should be wary about taking interests in companies which have been so organized. If an owner believes that a mine is worth ten times as much as a prospect, let him be consistent and offer his undeveloped property for a tithe of the capital stock in the anticipated mine. If he has a worthy piece of ground, he will reap the same benefits as the holders of the stock who place their cash against his title to a tract of virgin territory. If he will not thus act fairly, it indicates either a questionable piece of property or an avidity undesirable in a partner. It is accordingly advisable to shun offerings in such concerns.

Another matter to be considered here is that of overloading a fairly good min-

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ing enterprise with so much capital investment that the property cannot be made to pay proper dividends and fair interest on the capital. Many worthy, though perhaps small, mining concerns have made failures through a disregard for this economic feature. The proper adjustment of this matter is a serious thing and it should not be passed over lightly. Investors should look into this phase of mining thoroughly.

XVI

MINING INVESTMENTS.

One should be able to establish, in his mind, a distinction between the value of investments in operating mines and in prospective mines; and he should likewise be competent to fix some difference in his attitude when purchasing the stocks in these dissimilar projects. One should invest in an established mine with the same business precautions that would guide him in buying an interest in a mercantile establishment.

It is possible to obtain, through competent engineers, the approximate present valuation and the probable life of any mine and thus to arrive at conservative figures that will govern one's investments. But, when debating the purchase of stock in a prospect, a man should learn all the available facts concerning the geology and the organizers and should then decide, in his own way, whether he cares to make the purchase. Even the prospects



MILL OF THE ROODEPOORT-UNITED MINES, TRANSVAAL, SOUTH AFRICA.

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offering the finest inducements have been known to disappoint, just as some less promising prospects have occasionally exceeded expectations.

So, while there are certain safeguards to investments, there should also be accepted the uncertainties which must accompany the placing of faith in unseen things.

The same general rules for business success will attend both commercial and mining enterprises. Any incorporation must be handled according to recognized, successful methods, no matter what its scope or activity. In most lines of business, there is a likelihood of growth with longevity, there being no reason to limit the life of the usual mercantile business. With advancing years, a manufacturing company, for instance, with good management, will establish a reputation and will gradually increase its business and its stock in trade. But with a mine, the business is one which is most successful only when actually depleting the assets at the most rapid rate. With some kinds of mines such as coal, placer, iron or the "reef" gold mines of the Rand, the life can

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be very accurately forecast and all activities may be planned for specified periods.

In some kinds of mining ground—as for instance, the irregular masses of Leadville or the crooked and uncertain veins of Tonopah—there can be no predictions that will reliably or even approximately decide the probable life of the mining activities of any company. The duration of mines of this second class is wholly problematical. A few years ago, there was much discussion of this subject and one writer, who had collected statistics over an extended period and covering various kinds of mines, arrived at the conclusion that the average life of a mine is about eleven years. J. P. Wallace, in his work, *Ore Deposits for the Practical Miner*, in discussing this point says, “The average mine, if continuously worked, seldom lasts longer than three to five years. A mine is valuable not for what it has produced, but for what it is capable of producing.” This opinion cannot be borne out by facts, for the brevity he ascribes to the average mine is altogether unreasonable and his statement is pessi-

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mistic. The cases of mines which have petered out in three or five years are exceptionally few. It must be that the experiences of this author have been in "pockety" districts, for he could not have lived in any of the worthy mining camps of the world very long and have come away with any such notion.

To take care of this intrinsic feature of mining, and to place propositions fairly before the public, there should be attention given to the matter of recovering the invested capital before the expiration of activities through the exhaustion of mining assets, the ore bodies. This practice, known as "amortization," is being given more and more consideration as people come to realize this peculiarity of mining. Some companies are now so organized and managed that there is a guaranteed refund, at stated periods, or whenever profits have accrued, of fractions of the invested capital with accumulated interest thereon. These funds are calculated to continue over the number of years which it is presumed the mines will live so that upon the cessation

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of mining, the owners of the stocks will have been completely reimbursed with their original outlay in addition to the dividends that have resulted from the success of the enterprise. It is here that the problem of the life of a mine enters into economics, and it is important that it be given its due share of study. Amortization is not of American origin and it has not been adopted in this country to the extent which it is bound to be in the future.

One means of providing against an extinction of a mining company's activity with the exhaustion of the ore bodies in the mines is to provide new mining territory to which operations may be transferred at the proper time. This plan has been very successfully carried out by a number of large mining companies. When a mining company has been maintaining its identity for a considerable period, it has reached a very desirable stage of economy in the make-up of its various lists of officials, superintendents and engineers. All this efficiency can be very readily transferred to the operation of

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virgin mining property. Often much of the equipment of a mine can be moved and used again. When a mine is known to be nearing its finish, there is a hesitancy on the part of the owners in replenishing the equipment and sometimes the mining is kept up through the use of worn-out, inefficient apparatus when, were the owners expecting to continue mining, they would purchase and install the new equipment when it is needed.

One company in the San Juan region of Colorado prepared for the contingency by purchasing neighboring property to which it moved its operations. Another large company bought a large piece of mining property in Mexico, although its initial operations were in Colorado. Placer mining companies frequently dismantle, move and re-erect dredges.

XVII

MINE EQUIPMENTS.

There is a constant tendency toward the adoption of machinery for the performance of every mining act which, formerly, was done by manual or animal labor. There are good reasons for this tendency. Good, trained labor is scarce; wages are slowly but gradually rising; ores of lower grade must be mined, and the tonnages must be correspondingly greater. The increased economy in production can be brought about by the adoption of devices that will supplant, and even excel, muscular effort.

A machine can now be installed and can be operated by a single man to perform the work formerly done by many men. There have been machines invented to entirely, or partially, perform every operation in and around mines, and one might imagine an ideal mine in which all such machines were installed. But even there,

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we should have to grant the presence of some few men, for it would not be possible to keep all the machines working without human, intelligent control. In such a mine, it might be possible to maintain a large production with very few laborers or overseers. Fewer men means less wages, less labor trouble, fewer fatalities, and less time occupied in handling men into and out of the workings.

In some ways, copper mines are ahead of gold mines in their equipment. Coal mines have adopted car loaders which as yet and without any very good reasons metal mines have not.

Plants for mines must utilize the same sources of power as are used by any other plants. Steam and water have been the usual forms, but electricity is gaining in favor in places where it can be cheaply obtained. At a coal mine, we naturally expect to see all the power generated through the combustion of coal under boilers. At metal mines—which are frequently remote from sources of coal supply—we run across the use of expen-

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sive coal for all power purposes. When it is possible to obtain a sufficient supply and head, water is adopted to furnish the required power for operation. At mines, with water sufficient to produce a part only of the needed power, we may see both steam and water power utilized. In the cases of some mines which are distant from sources of both coal and water supply, power is generated at points where stores of natural energy are available for use and the power is transmitted (usually as electricity, sometimes as compressed air) over long distances to the mines.

Some mines cannot be economically operated without the treatment of the ores upon, or close to, the mining property. With certain sorts of low-grade ore, or with those kinds of ores that may be concentrated before shipment, provision should be early made for the erection of appropriately designed mills. We say the subject should be considered early, but we do not advocate the premature erection of any mill. The hills of the

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Western mining states are dotted with monuments to men's error in this particular. Here and there (not in our own country alone, but throughout the mining world) one may run across an abandoned mine plant, a complete mill, a smeltery, a railroad or an aerial tramway, all prematurely provided for outputs which failed to materialize.

There are men still trying to succeed in the mining business while thinking it is essential in mining that a complete plant be the first thing given attention. Upon the showing in a ten-foot hole, such men will induce capital to take interests enough to provide the wherewithal for purchasing and installing an equipment capable of handling and treating the output of a big mine. This is a grievous mistake that comes about through misconceptions. It is often true that ores of the kind these mines are expected to produce should be treated upon the ground. But it is also true, and far more essential, that there be enough ore to supply the treatment

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works. It is rank folly then to spend the money needed to make a mine upon a plant to handle the product. Money should be spent, first, in exploitation and proving the value of a property. If the proof is forthcoming, it is then time enough to erect the plant. Meanwhile, during the development stages of a mine, the proper amount of experimentation can be conducted to ascertain the correct process for treating the ore. If ores are produced in abundance, they may be shipped for treatment in custom works until such time as the company's own plant is ready; or the ores may be stocked up for emergency mill supply at future times when it may be compulsory to curtail the mine production because of accidents or other unforeseen causes.

One who considers these matters from an economic standpoint will recognize that there must exist some proper ratio of mine output to treatment capacity. Just what this relationship is constitutes a serious problem for each particular mine and there cannot be stated any

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ironclad rules that may be applied to all cases.

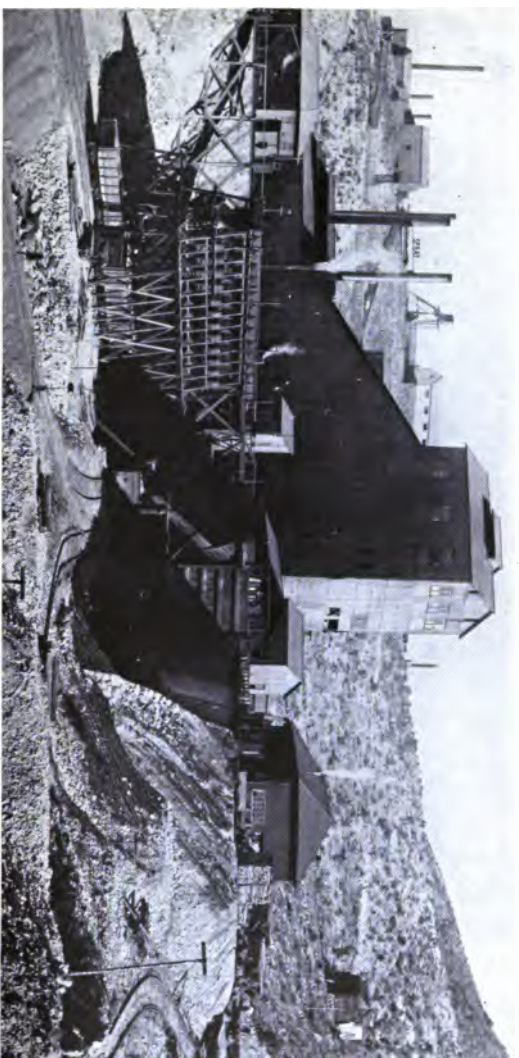
In the first place, we believe *a mine will be operated at its greatest economy when it is making its largest and most regular output.* This being the case, we must agree that the plant and mill must be capable of taking care of this maximum output. It would then seem axiomatic that the equipment must be calculated according to the mine's capabilities. But, in the youth of a mine, how are we to know what its mature capacity will be? Here comes the rub.

Very nice discussions along this line have been indulged in by British and American representative mining men. When speaking of operations that are typical of some foreign mining districts and especially those that possess ore-bodies whose extents are readily calculated, no clever prophecy is required to ascertain the proper amount of equipment. But there are many regions, especially in our own country, where nobody can predict, with any degree of

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accuracy, how extensive will prove to be the natural reserves of any mine. It is in such places as these that hard study and careful guessing are needed, and we are inclined to agree with George J. Bancroft when he says, "To my mind, there is more credit due to those who take up the hard propositions and make them pay than to those who exploit bonanzas along purely scientific lines. The first usually require energy, sagacity, perseverance and, very often, daring; while the others need chiefly cool calculation."

It is a safe practice, throughout the world, whenever there is no absolute means of reaching figures of a mine's ultimate production, to erect the treatment installations in units. By a "unit" is here meant the outfit of machinery and the other equipment which will handle a specified round number of tons per day. In some districts, a unit will be for the treatment of 10 tons; in other districts this number may run up to 100 tons. In the plans provisions are made for additions, from time to time, as mining



SPRAY SHAFT HOUSE OF COPPER QUEEN CONSOLIDATED MINING CO., BISBEE, ARIZONA.

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development warrants. Very much the same scheme should be followed in the erection of the plant for carrying on the operations, which are strictly those of obtaining the ore from the earth. That is, mining equipment, as well as the milling equipment, should be on a flexible plan so as to be readily adapted to an increased scale of operation. There must be space provided for harmonious additions to the initial plant whenever such extra parts are required.

XVIII

MINE MANAGEMENT.

No matter how splendid a company's holdings may be naturally, there cannot be expected any profits from the workings of the deposits if there be not a sound business management. H. C. Hoover, the prominent mining engineer and mine manager, says, "Good mine management is based upon three elements: first, sound engineering; second, proper coördination and efficiency of every human unit; third, economy in the purchase and consumption of supplies." And he goes on to emphasize the fact that "no complete manual will ever be published upon 'How to Become a Good Mine Manager.'" In view of this damper upon good intentions one might possess, and granting that the subject is one that cannot be taught (except along very general lines possibly), no attempt will be made to enter into arguments concerning this important subject of Mine Management.

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Good administrative ability can be improved by cultivation just as can an individual of the vegetable kingdom; but there must first be the existent, innate ability. No man should attempt such a hard proposition as the management of a mine, with its varied phases of activity, unless he has found himself possessing the fundamentals that go to assure success in managerial positions. Furthermore, he should not think, because he has been successful in running a clothing business or any other mercantile line, that he is certain to succeed in running a mine.

The duties of directors and president are pretty much the same in all sorts of incorporations. But, while there are many mining companies—and successful ones, too—that hold upon their directorates men who probably never saw a mine prior to their present ventures, it may still be stated that it is obviously advisable to select for such places men who have knowledge and sound ideas concerning the industry of mining. To be sure, if they are ignorant along min-

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ing lines, they can, and often do, place the blame for their shortcomings upon their manager, their consulting engineer, or their superintendent. But this is not an auspicious state of affairs and it were well for stockholders to see to it that they elect to the directorate men who are cognizant of mining economics.

The well-organized mining concerns of today maintain their engineering staffs just as completely as do other great technical businesses. The engineer is a very important man in mining affairs. His duties are probably more varied than those that appertain to any other sort of engineering. His operations will extend into the realms of the mechanical, the civil, the chemical, the metallurgical, the hydraulic, and the electrical engineers. He must be posted along the latest conceptions in geology, mineralogy, and physics. Besides he should be an accurate and rapid mathematician and draftsman.

The manager finds in the engineer his most helpful and trusted aid. Often the engineer performs many of the functions usually attaching to the office of

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manager and, in the absence of the latter person, he may attend to all of the management. As stated above, the qualities that make a good manager are inherent; hence, to a certain extent, we may hold the deduction that good mining engineers, also, must possess innate qualities. Yet there may be pointed out this distinction between the make-up of a good man for manager and that of a good mining engineer: one, as said, cannot learn his business except through his own experience, while the other can receive vast benefit by *study* of a theoretical nature and by *practice*.

Lately, there is much said about the *consulting* mining engineer. His field of usefulness is broad. He can be asked to add his opinions and recommendations to those of the regular engineer, at any time; he can be used at times when the duties are too much for the resident engineer; he can be called upon to substitute; he need not live near the property, but may visit it periodically. Thus, while his retention is deemed remunerative, his services are available at a

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fractional part of what he would demand if he were employed exclusively by the company.

Under ordinary working conditions, it should be considered just as essential for a mine to take an occasional inventory as it is for a mercantile establishment. In truth, there is far more need in mining operations of the knowledge thus derived than in any other business. In mining, as already suggested, the business is one of selling off the stock in trade without replenishing it. The opening of more reserves of ore is not bringing more goods into the stock, but it may be likened to simply unpacking more goods in the storehouse. No new reserve can be added—they can simply be found and unpacked, as it were.

This finding entails the greatest amount of concern, and upon its successful practice depends the life of the mine. The presumption is strong that many mines have been abandoned while they really contained possibilities; but lack of knowledge of things geological, or perhaps failures to explore, permitted the opera-

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tors to remain ignorant of the splendid assets that were available. Proof of this error has been found in many mines that have been subsequently re-opened.

The work of sizing up the quantity and the value of available ore is known as sampling. It is not well to limit the practice of sampling to the times only when a sale is contemplated. Reports based upon careful sampling should be issued frequently. Some companies employ men whose sole occupation is the daily sampling of every working face. The assay results obtained from the collected samples inform the superintendent just "how the stuff is holding up" throughout the mine and he governs his work accordingly. At longer intervals, the engineer should go into the work more thoroughly by not only taking very careful, scientific samples (not the usual "grab" samples taken by the daily sampler) but also by making careful memoranda of the physical appearances of the ore with its thickness and all geological data that will tend to throw light upon the permanency of each body. The

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engineer's monthly report will then be a substantial guide to the manager and the directors.

Managers, too, are expected to make periodical reports—monthly, quarterly, or annually—to the directors who, in turn, issue reports to the stockholders. The reports of managers and directors are not usually technical in their nature, although sometimes it is the practice of a manager to attach the engineer's report to his own for the perusal of such readers as may desire to dip into the technical affairs of the operations. Usually, the directors' reports are of a simple, financial nature, stating the conditions of affairs in plain business language to the persons whose cash has been invested in the enterprise.

It may happen that, for some reason, a special report is desired by the directors who may be contemplating some consolidation or other financial move and both the manager and the engineer will be required to furnish detailed statements concerning their respective branches. If a sale is planned, it may be that not only

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the company's engineer, but very probably another engineer engaged by the contemplative purchaser, will make examinations. They may work together or separately, as best suits them mutually, but it is upon the reports issued by them that the satisfactory price for the exchange of title is based.

XIX

PRICES OF METALS.

There is only one product of mines that has a constant market value, viz., gold. The precious metals, gold, silver, and platinum, are sold by the Troy ounce: the base metals are all handled and dealt with on avoirdupois weights. Copper, lead, zinc, tin, and nickel are quoted in cents per pound avoirdupois. Iron and manganese are curiously sold by mines to smelting companies on the ton of ore basis.

Since gold has been found in every known rock of every geologic age and is of world-wide distribution; since it possesses physical properties that long ago placed it at the head of the list of desirable metals; and further, since it does not occur in very condensed amounts, generally; this metal was selected as the standard of value by which the worth of every other commodity in the world is fixed. It must therefore be possessed of

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a fixed market value, and one never looks for quotations on pure gold. The price of pure gold is set at \$20.6718. This very peculiar value is known as the "mint value," and is the price which the Government of the United States pays for all of its coinage gold. Among miners, as a rule, the price is thought of as \$20 per ounce, and this is probably because this is more nearly the actual return the miner has been accustomed to obtain from companies who have bought and treated his ores. Most all the gold produced in the world is associated with other metals, such as silver, copper, or platinum, so that the bullion recovered in milling or smelting will usually contain the gold alloyed with such other metals and the gold is said to be not "fine," or pure. The fineness of gold in the metallic state is expressed in two ways. Jewelers have the carat system, while mints use the decimal system in expressing such degrees of purity. Pure gold is 24-carat fine. An alloy of 3 parts gold and 1 part copper would be considered as 18-carat gold. In the decimal system, pure gold is called

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1,000 fine, and the various degrees of purity are then expressed in their true proportional amounts. Thus the same alloy as cited above would be called 750 fine gold.

Silver has a fluctuating market value although attempts have been made, at times, to establish its value at some fixed ratio to the value of gold. In fact, a reader may occasionally run across statistics of silver production in which it appears as though there were a fixed value for the metal, but this will be found to be due to the use of what is known as the "coinage value," which is \$1.29198. This figure will be recognized as our old acquaintance, "16 to 1," *i.e.*, this price for silver being one-sixteenth of the fixed price for gold. There is actually no such fixation, and prices for silver are established every business day of the year in the great metal markets of the world, London and New York.

Platinum has been increasing in market value during recent years and the quotations have ranged up so high that it is now more than twice as valuable as gold.

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The reasons for this high price are that the production of the metal is limited, whereas the uses for the metal have been increasing. The greatest production of this metal is in the Ural Mountains of Russia, and the output from this region is handled by a few concerns who virtually possess a monopoly. These companies are able to maintain the production practically constant and to cause the market price to fluctuate.

Tin is found in commercial amounts in but very few regions. There is but one mineral mined as an ore of tin, viz., cassiterite, the oxide, which is 78 per cent tin. Tin is found in both veins and placers and the great bulk of the metal is now being derived from the latter type of bodies in the Malay Peninsula and the Straits of the East Indies. Formerly, Cornwall produced the world's supply, from veins. Although the United States consumes 35 per cent to 40 per cent of the world's production, the country does not produce 1 per cent of this production. Since the main source of our tin is British territory, the markets are controlled by

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London, and quotations are issued daily from that center. Such quotations are given in units of English money per long ton (2240 pounds) of metal. However, prices are also quoted at New York, daily, in cents per pound, and there is a real difference in value between the two quotations to take care of freights and duty. For instance, on a certain date, quotations were £190 10s, and 42c. The average price during 1911 in New York was 42.281 cents.

The chief supply of nickel now comes from the Canadian districts of Cobalt and Sudbury, where this metal occurs accompanying rich silver deposits. The metal is sold by the pound avoirdupois and prices in January, 1912, ranged from 40c. to 50c.

Tungsten is a metal which has been finding more and more uses of late years, but the production has remained quite limited. Three-quarters of the world's total production in 1911 came from a small district in Boulder County, Colorado. The quotations on this metal are given in dollars per ton of concentrated

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ore, and the price is for a certain percentage of WO_3 , the oxide of wolfram (tungsten). The schedule of prices announced in April, 1912, for Boulder County ores and concentrates provides as follows, a unit being understood to mean 1 per cent or 20 pounds per ton: For material assaying 10 per cent WO_3 , \$3.50 per unit; for 20 per cent WO_3 , \$4.40 per unit; for 40 per cent and more, \$4.90 per unit. Ore containing, say, 50 per cent of the tungsten radical is thus salable at \$245 per ton, the mineral itself thus bringing a price of $24\frac{1}{2}$ cents per pound. /s

Although copper is used and sold in very large lots commercially, it continues to be quoted upon the pound basis. The United States produces about 60 per cent of the whole amount mined in the world and the prices are made in New York daily. The amount of copper mined in this country in 1911 was 1,431,938,338 pounds and the price varied between 11.989 cents and 13.768 cents. There are always at least two quotations every day on copper, one being on "lake" and another on "electrolytic." By these terms

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are meant, respectively, copper produced in the Lake Superior region and the copper from other mines. The Lake Superior copper is the purest in the world and it always sells for a fraction of a cent per pound more than the other coppers which are refined by electrolysis.

Metallic iron is reduced from a number of different ores, but by far the bulk of pig-iron is made from the oxides and carbonates of iron. Such ores, in the United States, are obtained principally in Minnesota, Michigan, Wisconsin, and Alabama. As already stated, the quotations on iron are based upon the ores rather than the pig-iron, and there are two types of such ore recognized. If the ore is suitable for the making of Bessemer steel, it is given a certain quotation per ton, while if it cannot be used for such a purpose, it is given a non-Bessemer rating and is used for casting. The greatest iron-mining region in the world is in the Lake Superior country. Here are a number of districts that are known as "ranges." In some of these ranges mining is by underground methods, while in others the

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excavation is entirely in the open by the use of great steam shovels. The outputs of these ranges go by rail and water to the great smelting points along the Great Lakes and at Pittsburg.

The metallic zinc on the market is known as spelter. All quotations on this metal are given in two systems, the "pounds Sterling per long ton" and the "cents per pound." The average prices during 1911 were respectively, £25.281 and 5.758 c. The American quotations are frequently given in the unit of dollars per hundredweight. This offers no confusion, whatever, for under this nomenclature, the average price for 1911 would be stated as \$5.758. In the zinc-mining regions of the Mississippi Valley, the producers of ore have a practice of putting the mines' products through their own mills at the mines and making concentrates of the zinc mineral, which is usually blende or "jack," and this concentrated stuff is then sold to smelting companies at the daily quotations per ton of 60 per cent ore. During 1911 the average price paid in the Joplin District

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was \$41.45. Since this amount bought 1,200 pounds of metallic zinc, it is evident that the miner received only about 3.45 cents per pound for his metal, the discrepancy between this sum and the New York quotation being consumed in costs of smelting and shipment and in profits to the middlemen.

Lead is sold upon a plan exactly similar to zinc. It has the same various quotations. For example, the 1911 prices in London, New York, and Joplin averaged, respectively, £13.970, 4.420c., and \$56.76.

Quicksilver is sold by the "flask" of 75 pounds. The price ranges in the neighborhood of \$43 to \$45.

There are numerous other metals, but the more common ones are given above. Below is given a graphical exhibit of the course of the prices of lead, spelter, standard (electrolytic) and lake copper, pig-iron, and tin for a number of years. A study of this chart is interesting in noting the waves or fluctuations that have covered periods of years. This chart is reproduced from *The Engineering and Mining Journal*.

XX

MINE ACCOUNTING.

While there has been a great deal of attention given to the matter of keeping systematic mine accounts, both in the main offices and those at the works, there still is a lack of uniformity in practice. In the bookkeeping of manufacturing and mercantile institutions, uniform practices or systems have become a feature. But there have been good reasons for the absence of similar methods in mine offices.

There will be found to exist some uniformity in the accounting as practised by the mines of a particular district which are operating under similar conditions; but when one considers that the mines of various districts have quite dissimilar conditions throughout almost every phase of the business, it is not surprising that different methods must be employed in the keeping of their accounts. It is unavoidable. Mines extracting different

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metals or different kinds of coal will find it necessary to keep quite unlike records. Mines with their own mills will likewise require a different system of accounting from those that ship their products to custom works. Open and underground mines will need quite different styles of accounts.

So, it is not possible to recommend any one method of mine accounting. The best way to become posted upon this subject is to investigate the schemes, the blank forms and the books of some of the established, successful companies here and there about the world. In this way, ideas will be collected, and it will be possible for the investigator to evolve his own schemes for recording the accounts of his company.

It has come to be recognized as contributing to economy to maintain systems of accounts that will enter into minutiae concerning every branch of the business. Just how far this can be carried without creating office expenses that will exceed the benefits to be derived from the detailed information remains a question

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to be decided by each manager. There are companies with accounts so perfected that it is possible to quickly ascertain, to a fraction of a cent, what the expenditures of any day have been for any particular part of the operations, as for instance, the haulage per ton underground, or the fuse employed in the blasting of a particular stope. Such details are highly useful since they prevent leaks in the costs; but it is a problem to decide to what extent it is economy to carry them. These data also furnish the superintendent information concerning the efficiency of his many laborers and the machinery. Labor-saving inventions, such as the printed blank form, and the loose leaf, are put to excellent use in mining offices.

There are strong companies operating great mining plants whose records are open to the perusal of any individual, be he stockholder or not. In the office of such a company, a person may turn to the accounts and see for himself how much it costs to maintain each and all of the operations and he can learn the

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size and the value of all shipments of products of any sort—ore, concentrates, coal, matte, or bullion. Again, there are those companies that are so secretive about everything connected with their work that even the Government is unable to learn any particulars, except at very great trouble.

The Portland Gold Mining Company, operating a great property at Victor, in the Cripple Creek District, is an instance of the first sort, while the United Verde mine, at Jerome, Arizona, may be taken to represent the second sort. Both of these mines have made splendid records. It cannot be seen wherein the second mine is required to maintain secrecy, for there is no danger of litigation from neighboring property holders, the one company controlling, practically, the mining in its neighborhood. The presumption is that the owners hold their business to be nobody's else and they have a right to keep their affairs secret if they desire. On the other hand, the Portland is surrounded by good mines which profit by knowing the details of

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operating costs and incomes of their neighbor; but it is found to cost no more to be open and above board than to keep things under guard. The Colorado Fuel and Iron Company will not divulge any particulars concerning its mining movements; but there are other just as great mining companies that will explain every detail.

The Clark copper companies, of Butte, Montana, did not permit much information to escape their offices, while the neighboring Amalgamated companies gave particulars freely.

The question of secrecy should be considered, and if there is no very good excuse for maintaining a privacy it should not be instituted. The trend of all modern thought is along the line of publicity in all our dealings. The only persons who have a reasonable right to be secretive are those who have something they do not care to share or divulge to their fellow-men. Law breakers, tax dodgers, and trespassers, could be put into one class; persons doing research work which it is premature to publish are a more

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respectable class; manufacturers with strong competition in the sales markets are in a measure excusable; even a mine which is producing some material in the sale of which it attempts to maintain a monopoly might be excusable. But it is hard to see what excuse or benefit there is for a coal or a copper mining company to prevent a knowledge of its affairs, if the business is being conducted along strictly legitimate lines.

XXI

INVESTMENT IN MINING STOCKS.

As a feature of investment in mining stocks, there has always been a more or less open lure. Generally much larger returns are promised or are expected than in other kinds of investments. There may be absolutely no intention on the part of the seller to create this impression; but there does, somehow, exist in the memories of people accounts of wonderful fortunes that have been made in mining.

There is an amount of uncertainty about any mine or prospect that appeals to the speculative proclivities in humans and it is hard for most persons to resist the notion that greater or richer bodies of ore may, at any time, be discovered in their particular mining properties. Concerning the average stock purchaser, then, we may conclude that it is speculation rather than true investment that he is seeking.

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The writer hopes that, even in the short preceding discussions, the reader will have come to agree with him and to understand that safe investments are as possible in mining as in any other business. It would be a great benefit to this great industry of mining were the public taught to take interests—that is, financial interests—in mining concerns with the same precautions and with the same sound business sense that accompany the purchases of interests in other enterprises. Writing along this line of thought, Mr. P. A. Leonard has this to say in *The Mining World*: “One very general difficulty seems to be that the man unacquainted with mines who is asked to invest either expects an unreasonable return for his money, or he blindly closes his eyes and takes what he calls a ‘flyer,’ expecting little more from it than he would if he bought margins on ‘change or bet on a horse race.”

About the first thing that the promoters of a new mining company do is to issue a neat, attractive prospectus. It is a bait, no matter how reliable these men

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may be nor how worthy the property they desire to work. Many of these documents are written in absolutely good faith and every representation is intended to be accurate. There are occasionally offered for sale stocks in mining properties that warrant the fullest confidence of the promoters and the investors. However, careful perusal of a great many of these pamphlets has led the writer to the conclusion that at least 75 per cent. of them are unreliable from the fact that they either wilfully misrepresent or because they grossly exaggerate the probabilities of success beyond all reason. Exaggeration is a habit with some people and it is used many times with no real criminal intent or even consciousness upon the part of the offender. But its effect is just as baneful when innocently inflicted as when it is used in a premeditated manner.

Good, worthy mining property does not need to be hawked, usually. There have been periods of financial unrest when it has seemed quite impossible for honest men to dispose of interests in

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what were unquestionably reliable mining enterprises. At such times, there has been nothing to gain by any amount of teasing the public, and any attempts at forceful disposal of interests in the concerns have but served to kill any small remnants of confidence that the public may have possessed.

Prospectuses are usually prepared for the reading of small investors who may feel inclined to risk a few dollars or, in other words, to speculate upon the representations contained in the seductive pamphlets. There are a few "Don'ts" which it would be well for any person inclined to invest in mining stocks to read, consider, and follow. For instance, never invest in any new stock whose company *guarantees* specific dividends. Profits in mining, except in rare cases, cannot be so accurately foretold as to warrant such a guarantee. We should remember that the success of any mine depends upon many, very many, contingencies and that some of them are invisible and are among Nature's secrets. Again, avoid placing any confidence in

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those companies that are simultaneously selling treasury stock and declaring dividends. This is a very common practice of the numerous "get-rich-quick" concerns which Uncle Sam has been routing the past few years. Such crooked practice is difficult to eradicate, although severe penalties are awarded the transgressors.

The success which has been met in the operation of the *great* mining companies of the world can, in the majority of cases, be traced to the common sense which was exercised in the business management. The *business of mining is legitimate*. If mining is one of the basic industries of the world, how could the operation of a real mine be anything but a legitimate business? The mere fact that there have been neat opportunities for, and the practice of, fraud in the growth of this tremendous industry does not by any means, argue that the whole thing is founded upon unstable premises.

What is needed is a presentation of the industry in its legitimate aspect before all kinds of investors and this can be

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done properly and effectively only by the rank and file of men interested in mining. These men should place themselves boldly on record as combating all sorts of deals that smack of fraud, and they should do their utmost to discourage all delusions that may exist in the mind of the public with reference to the supposed lure offered by mining.

There have been too many causes of failure in mining for even a partial enumeration of them. There have been many errors in getting started, both on the part of the organizers and the investors. There have been many mistakes in management. Many blunders have been evidenced in the operation of mines which made very good starts. All of these failures are attributable to something outside of the mine's intrinsic worth; they are mistakes due to inexperience or misconception. Such shortcomings should not be tolerated in the make-up of a mine's managerial staff.

Perhaps one of the most common mistakes of mine managers is to submit to a condition of nepotism that is often fur-

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thered by directors or stockholders. No responsible position around a mine should be filled by a novice. Just because a director has two or three sons needing situations does not make it incumbent upon a superintendent or a manager to jeopardize his reputation by employing these young men. Percy Williams, a veteran mining man, advised "Don't take your son or nephew or your clerk out of your store or business house and send him to Arizona or Colorado to run things for you at the mine. Sell out first. If you are a director in a mining company, do not force the manager or superintendent to find a job for all your unsuccessful friends and relatives. Let him hire his own men. Don't convert your mine into an asylum for ne'er-do-wells."

As already stated, there is protection obtainable by every investor in mining. One may always secure, at reasonable cost, the services of competent engineers whose business consists in sizing up the worth of mining property. If the services of these men were more generally appreciated and secured, there would be

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a great diminution in the number of disappointments following investments in mining. An eastern man of means complained to the writer about the way in which he had been "stung" in various mining investments. A little catechizing brought forth the facts that he knew absolutely nothing about mining in general and that, worse still, he had never investigated—that is, in a businesslike manner—any of the propositions which had absorbed his ready money. Receiving no sympathy during the recital of his troubles but, instead, the assurance that he "got what was coming to him," he was prepared to sit up, take notice, and listen to a severe roasting which opened his eyes about mining matters. Now, this man has proved successful in other lines of business. He is a prominent lawyer and banker in his own city and has numerous, scattered, money-making interests. But he was content to go into mining without the investigation which it is certain he would have given to any other sort of an investment.

The time should come when there

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would not be such a prevalent "slaughter of the innocents" in mining investments. People must learn to curb their gullibility in such affairs. But this has proved almost impossible. Just as it is in the nature of some persons to gamble, and it takes something more than misfortune at gaming to wean them from the vice, so it is with a certain class of men who can not overcome the temptations of dabbling in mining. Such men will not desist even when they have suffered several delusions, and will continue to "send their good money after their bad," absolutely defiant of the well-meant advice of friends who are often in position to judge of the merits of any contemplated investment. Probably every mining engineer of any extended experience can tell of instances in which he has endeavored to discourage clients from investment in unworthy mining enterprises but in which the gambling instinct of the clients has overridden the sound advice.

During the early days of the wonderful Cripple Creek District, all sorts of wildcat tricks were successfully practiced

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upon the "tenderfeet" and the "down-east suckers." In one case, stock was readily unloaded upon the representation that a person could stand in the door of the cabin on the property and "look right into the shaft-house of the Independence mine." This statement was not untrue, although grossly misleading; for while it was actually quite possible by the use of a telescope to span the intervening three or four miles, visually, the prospect lacked the propinquity to the famous mine that was the bait implied by the statement in the prospectus. This is but one of many ingenious tricks that were played. Did the outcome of this one fraud cure the victims of irrational mining investment?

Railroads, too, have, in the past, added their troubles to the mining men. Recent laws have, however, to a great extent, mitigated the annoyances and unjust practices that the common carrying companies have been in the habit of committing. It is now obligatory upon a railroad company to treat all shippers without favor or discrimination, so that the diffi-

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culties formerly experienced by one mining company in getting enough ore cars to transport its shipments while its rival company could have cars in abundance, is now almost a thing of the past. It takes time to right all wrongs of this sort. It is a slow matter to get laws framed, passed through the necessary legislation, and made effective. But the outlook is favorable, along this line.

The leasing system has exercised an influence upon the mining activity of many districts. By this system is meant the custom of renting or letting the whole, or fractional parts, of a mining property to miners who enter upon and work the premises, extract the ores, and pay to the owners a specified percentage of the receipts from the marketing of the ore. This practice has frequently been the only successful way of operating some mines. It has, at times, been the manner of operating practically every mine in certain districts.

In districts carrying pockets of very rich ore, "high grading" has been discouraged in this way, for the "leasers"

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(incorrect, though common, word for lessees) do their own mining and there is much less object in stealing.

In other instances of mines which have been operated by the owning companies until they were past a profitable stage, it has been proved possible to prolong the life of operations very materially by leasing the property to miners, who always work with more diligence and economy for themselves than they ever do when working under "day's pay." This feature of leasing has been quite a factor in the lives of some of the mines of the Cripple Creek District. Until the recent drainage of the district through the Roosevelt Tunnel, there were numerous small—and even some large—properties that had worked all the ore bodies previously known to exist above the water level of the district, and had been obliged to shut down because of the heavy pumping expenses. Company operation did not longer pay. But the plain "leaser" and his partner could go into such old workings and they could prospect and find ore bodies that had escaped the observation of the sup-

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erintendents. The expenses incurred in leasing are low. It is true that lessees will not probably take as good care of mine workings and equipment as will "company men," and often a property may be seriously crippled through the lack of sufficient timbering after having been in the hands of a set of lessees for some time. But, on the whole, there has probably been more benefit than loss through the letting of leases.

When, a few years ago, the plans of the National Forestry Service were put into effect, there was great complaint recorded concerning the rulings that were made against various miners. Some very well authenticated cases of wrongs were cited. However, it is now believed by all fair-minded men that there has been no intention, on the part of the officials of the Forest Service, to interfere with any legitimate mining enterprise. There was a well-founded object, viz., to put a stop to dishonest practices in obtaining title to timber lands by the misrepresentation of mineral finds.

The General Land Office passed a rule

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authorizing Foresters and Assistant Foresters to make inspections of all mining claims within their reserves and to report to the Secretary of the Interior. The idea embodied in this rule was that these men, being agents of the Government and upon the ground, are able to investigate the facts concerning every mining claim and its claimant and so to run across any evidences of fraud that might be attempted in the securing of title. Trouble immediately arose because the Foresters were not all experienced miners and prospectors and so were not thoroughly qualified to pass judgment upon the merits of mineral lands. This weakness has been admitted by the officers of the Service but the excuse has been offered that there was an immediate need for a great many Foresters and it was not possible to secure men trained in both forestry and mining at such short notice. "Just as soon as conditions became better understood, and money was available to allow the Service to hire men whose judgment in mining matters could not be gainsaid, such men were employed," says Paul G. Reddington,

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recently Forester for the Rocky Mountain Regions. It is true that much fraud has been prevented in the practice of taking up Government lands and it is also quite true that the Forest Service is endeavoring to uplift the mining industry in the western portions of the United States.

Mining is bound to become a still stronger factor in civilization as metallurgical processes multiply and there are discovered means of more economically extracting the valuable contents of ores. Minerals which are not now ores—according to the accepted, scientific definition, because the values cannot be recovered at a profit—will, at some future period, become ores. It is not safe to make any close predictions along this line, for such marked reductions in treatment costs have been going on during the last few years that mining men are entertaining great expectations. Inventions for improvement in metallurgical lines are being placed upon the market so frequently that it is difficult for even the professional metallurgist to keep posted. This being true, it is clear that

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the layman cannot expect to keep abreast of the metallurgical advance. At the same time, it is well for everybody to be slightly conversant with the wonderful advances being made in the reduction and dressing of ores. Conspicuous in this field are the improvements that have been effected in cyanidation, electrolytic amalgamation and extraction, and flotation. These processes are applicable to the lower grades of ore. Among the very recent successes in the treatment of very low-grade gold ores are the operations conducted in the new mills of the Portland Gold Mining Company, Stratton's Independence, and the Ajax Gold Mining Company, all in the Cripple Creek District. All of these mills are now treating old mine dumps, the contents of which were considered as absolutely waste matter at the time it was excavated. This stuff is now ore and its treatment is making fine profits. There is still a demand for cheaper methods of reducing ores of zinc. There are vast quantities of stuff that contains very good percentages of zinc, but the material cannot be mined



FLORENCE MINE AND MILL, GOLDFIELD, NEVADA.

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and treated at a profit under existing conditions. With the invention of something radically new in the metallurgy of this metal, there will be opened an entirely different aspect in the zinc-mining regions. The Leadville District possesses great reserves of this material that is being held until it may become "ore."

XXII

THE MEN OF THE FUTURE IN MINING.

The mining of the future will probably be largely in the hands of young men. To arrive at any conclusions concerning the probabilities of success, therefore, we are obliged to recognize the dual conditions. In other words, there is to be an interdependence between men and mining. Up to this point in our discussion, we have dwelt upon the probabilities as viewed from the standpoints of natural resources and of human capability. In a certain degree, we have already covered the ground of this present chapter; and yet there are some points that must be given special consideration.

What is the true status of metal mining? Alarmists would have us believe that civilization is rapidly exhausting the world's reserves of available metals. Conservative investigation, however, repudiates such notions. The best that can be

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claimed for the reliability of such disconcerting statements is that they may apply in *some* districts, to *some* grades of *some* kinds of desirable mineral matter.

It may be true that the early miners have removed the "cream" from Nature's deposits in some districts, in the sense that they have skimmed off, as it were, the rich surface portions. But this does not signify the exhaustion of deeper ore bodies, nor does it mean that the pioneers were the only capable prospectors.

Why should we have any reason to deny the ability of present or future generations to find just as good mineral deposits as did our predecessors? Persons in some of the older of the western mining states—as for instance, Colorado or California—are apt to carry a misconception along this line. They can see a number of idle "camps" that are mere relics of former thriving mining communities and they are liable to jump to the conclusion that the day of mining at such places is past, forever. However, as we look at the subject in a more rational light, we shall see that there is no more authority

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for such an assumption than there is for one to the effect that a farm in the winter-time is a worthless proposition simply because, temporarily, it is not producing its customary summer yield. Just as Nature brings about changing conditions for the farmer, so will economic forces establish varying degrees of attractiveness to the miner.

It is unfair to judge one of the pioneer mining districts by its activity at the present time, if the productiveness happens to be small. Let us look for the reasons of the apparent decline. The chances are that the inactivity will be shown to be due, not to an exhaustion of ore bodies, but to some needed changes in mining or metallurgical methods. Very likely, under a readjustment of our notions about that particular district there will appear to be as great latent possibilities as ever cheered the earlier operators. The prospects may appear to be even better than this, and the future may appear to extend greater opportunities than were ever manifested in the past. Investigation may disclose great bodies

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of ore that could not be seriously considered in the earlier working of the region. In fact, speaking technically, the stuff in question was not ore at the time of previous operations, for it could not then be made to yield a profit. And yet, by introducing some changes in equipment or methods of working or treatment, there may be possibilities of making a great deal of money from an abandoned property; and the chances are good that this same profit may be won at a much more rapid rate than was ever before possible and that therefore the economic conditions are enhanced. For we must not lose sight of the fact that the greatest profits in mining usually accrue from the most rapid exhaustion of the ore bodies.

A mine, or even a whole district, may have been deserted because of failure on the part of original miners to recognize the value of certain minerals. The recent revival of activity that has been noted in Leadville mining circles is but an instance in point. In this district, miners have given a delayed recognition to some important minerals of zinc, and

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the indications are that Leadville has entered upon another of its eras of mining activity.

But, it is not necessary to restrict our thoughts to the old mining regions, for if we can observe how easy it has been to overlook valuable deposits in a country that has been subjected to severe mining work, for years and years, what must we conclude concerning the possibilities of the many and vast undeveloped areas in remote portions of the globe? It would seem that there is indeed very small cause for alarm about the exhaustion of the earth's metals.

No, it can be shown that mining, which is one of the very fundamental industries of the world and the one upon which every other form of commercialism rests, will be carried on with a continual increase in magnitude just as long as man exists. As the richer and more easily mined ore reserves of Nature are exhausted, improved and cheaper methods of mining, transportation, and treatment will be introduced and at a pace that will equalize this exhaustion. We, of the present gen-

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eration, see the eminently successful handling of copper ores of grades so low that they were not given passing consideration ten years ago. The outlook would appear to be that the improvements in methods and costs will not only keep abreast of needs in such matters, but the probabilities are that they will take a very marked lead, with the result of a continually increasing scope to the mining industry. Let us then entertain optimistic views about the *future of mining*.

Now, as to the future of the young man who engages in mining there is just as much to be said as there is concerning the career of a young man in any other line of business. This word "business" is used advisedly, for the day is past when any person has a right to say that mining is anything but strictly legitimate business.

We look to the young men of the present and future to correct all of the shortcomings that have hindered the establishment of mining upon its deserved plane of stability in the minds of the general public. Young blood will take a lead in

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the dissemination of the correct thoughts about mining.

The successful man in mining will be, as heretofore, the one with the right qualifications in his make-up. Is a college education an essential prerequisite to success in mining? No, the writer is not one to declare that young men cannot succeed in the business without college training. However, there can be no avoidance of the proposition that the chances of the college-trained man are better than are those of the man who has not had the benefits of such a career.

A man may be said to engage in mining in three different ways. Thus, he may operate mining property; or he may perform any of the manifold lines of mining engineering; or he may be an investor in mining property or mining stocks.

To prove a success when enrolled in either of the first two classes, there is no denying the advantages of technical, mining education. The successful investor likewise will do well to make a consistent study of mining economics, and the

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more attention he gives to the many phases of approved modern mining, the greater will be his ultimate achievement, financially. Just as education along usual school branches is of immeasurable benefit to any man of business, so is it to the mining man. And in just as great ratio is the possession of innate business ability.

Education and natural ability are the two elements that will count in the future of any young man in mining.

Space might be devoted to the discussion of the possibilities of young men in the field of research work along scientific lines that would add materially to the economy and scope of mining. Such a career offers inducements looking to the achievement of honor as well as fortune. The field for such service is ready.

XXIII

MISCELLANEOUS CONSIDERATIONS.

There are regions producing ores that are too refractory for the simple treatments that might be given by company plants located at the mines. There are districts that have many small gold and silver mines with ores that do not yield to simple milling processes and which must therefore be shipped to custom smelteries. Even were the ores amenable to milling of some sort, it is often the case that the mines are not of sufficient magnitude to warrant the maintenance of their own treatment plants.

Under proper trade and commercial conditions, there is no impropriety in shipping ore to a custom plant or in selling it outright to a company owning such a plant. But, contemporaneously with much of the mining in the West, there has been such a monopoly on ore treatment that great injustice has been

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wrought to the shippers of small lots of ore. Not only has this accusation been true of smelting concerns but also of milling companies. Once in a while representatives of such corporations will arise and attempt to refute these statements, but the evidence is overwhelmingly against them, and their arguments of being benefactors of the miner fall flat.

By consolidation of companies and the elimination of competition, arrogant methods and unreasonable charges have been put into force; and the managers of mines have been obliged to accept whatever rates the monopolists saw fit to charge for treatment and whatever arbitrary prices they cared to pay for the metallic contents of the shipped ores. Very gross extortion has been practised and even yet there are many mining camps which are so absolutely under the control of these concerns that properties which should pay well, under just and favorable conditions, are forced to remain idle. These conditions could not be expected to prevail forever, and the time

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is now at hand when the extortionate smelting and milling trusts are meeting with pronounced opposition and a greatly diminished business. The state of Utah has demonstrated the ability of ore producers to bring the oppressors to time and the mine owners of that state are in a much more favored position right now than are the miners of Colorado, for instance, who really have been the greater sufferers. The Utah mining men have benefited by the sad experiences of the miners of the sister state. In Colorado, the American Smelting and Refining Co. has been a domineering factor in the mining industry for years, and the decrease of mining in Colorado has been contemporaneous with the oppression of this great corporation. The real cheating that has been practised by the ore-buying and ore-treating companies is well understood by all mining men who have been within their clutches.

It seems to be a fact that every tyrant eventually proves his own undoing. In the case of the oppressive smelter trust, the greed resulted in an immense income

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for the time being; but as mines were obliged to close down because of the unjust charges imposed for handling the ores, the quantities of ore handled continued to diminish. During the past few years when mining has been so unusually dull in many of the western mining camps, it has been very difficult for the smelting company to secure enough ore to keep running, and the present outlook is not encouraging. Statistics will show that the production of the metals is not really so low as the decrease in tonnages would seem to indicate, and the discrepancy is accounted for in the fact that very many mining companies have installed their own plants for either actually recovering their metals or for reducing their bulk of ores by concentration before shipping to the custom treatment plants. Thus the smelting company may still be turning out a large amount of metallic lead, for example, but it is smelted from concentrates instead of from crude ore and the tonnage, the principal basis for estimating smelting charges, is very much less than was formerly handled in obtain-

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ing the same amount of the same sort of product. The investigations started by the oppressed ones in their efforts to evade the oppressor have led to wonderful results, and it is no longer necessary for the miner to depend upon the smelter.

Some similar sharp practice against the mining fraternity was attempted and for a short time successfully carried on by what was termed, in Colorado, the milling trust. This concern handled the ores from Cripple Creek, principally. The larger mining companies soon began the erection of their individual plants and the practice has been extending until it is now common for Cripple Creek mines to own and operate their own reduction works, much on the order of the practice in the Transvaal country.

As a final word in this discussion, the author wishes to reiterate his belief in the legitimacy of investment in mines and mining stocks. When mining is placed upon sound business principles and every detail of the work is carried on with strict attention to sound economy, there can be few failures. This means that business

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judgment and expert advice must be used from the very start—in other words, that no false starts must be permitted. Then, after getting under way in a worthy enterprise, the successful mine operator will exercise just as close scrutiny of every operation, method, and employee as do the men who conduct other successful lines of business.

This little work has been prepared primarily for the perusal of men and women who are not personally acquainted with details of mining, but who entertain notions of becoming financially interested. It is hoped that the simple descriptions of some of the elementary details will prove of use to a great many persons.

THE BUSINESS OF MINING

CAPITALIZATION AND DIVIDENDS OF NORTH AMERICAN METAL MINES.

Company	State or Country	Metals Produced	Capitalization	Par Value per Share	Dividends to Jan. 1, 1912
Alaska-Mexican.....	Alaska	gold	\$1,000,000	\$5	\$2,634,381
Alaska-Treadwell	Alaska	gold	5,000,000	25	11,385,000
Amalgamated.	Montana	copper	155,000,000	100	63,579,315
Anaconda.	Montana	copper	30,000,000	25	47,700,000
Arizona.....	Arizona	copper	3,669,300	1.20	14,373,550
Baltic.....	Michigan	copper	2,500,000	25	6,050,000
Boston & Montana Cons..	Michigan	copper	3,750,000	25	62,425,000
Bullion-Beck & Champion	Utah	silver, gold	1,000,000	10	2,738,400
Bunker Hill & Sullivan...	Idaho	silver, lead	3,000,000	10	12,211,350
Butte Coalition.....	Montana	copper	15,000,000	15	2,450,000
Calumet & Arizona.....	Arizona	copper	2,500,000	10	11,500,000
Calumet & Hecla.....	Michigan	copper	2,500,000	25	112,750,000
Camp Bird.....	Colorado	gold	5,387,000	5	6,541,960
Centennial-Eureka.....	Utah	gold, silver	5,000,000	25	2,700,000
Champion.....	Michigan	copper	2,500,000	25	5,700,000
Colorado.....	Utah	silver, lead	200,000	0.20	2,270,000
Copper Range Con.....	Michigan	copper	40,000,000	100	10,751,180

NORTH AMERICAN METAL MINES

Crown Reserve.....	Ontario	silver	2,000,000	1	2,387,898
Daly.....	Utah	gold, silver, lead	3,000,000	20	2,925,000
Daly-West.....	Utah	gold, silver, lead	3,600,000	20	6,201,000
DeLamar.....	Idaho	gold, silver	400,000	5	2,737,520
Doe Run.....	Missouri	lead	10,000,000	100	2,448,478
Elkton Con.....	Colorado	gold	3,000,000	1	2,666,959
El Oro.....	Mexico	gold, silver	5,750,000	5	12,426,590
Esperanza.....	Mexico	silver, gold	2,250,000	5	10,752,750
Federal.....	Idaho	silver, lead	30,000,000	100	8,300,000
Gemini-Keystone.....	Utah	gold, silver	500,000	100	2,000,000
Goldfield Con.....	Neveda	gold, silver	50,000,000	10	11,027,812
Granby Con.....	B. C.	copper, gold, silver	15,000,000	100	3,778,630
Greene Con.....	Mexico	copper	10,000,000	10	6,137,800
Guggenheim Exploration.....	Mexico	all metals	22,000,000	100	10,151,995
Hecla.....	Idaho	silver, lead	250,000	0.25	2,090,000
Hercules.....	Idaho	silver, lead	1,000,000	1	3,132,000
Honestake.....	South Dakota	gold	21,840,000	100	19,955,550
Hond. Rosario.....	C. A.	gold	1,500,000	10	2,955,000
Horn Silver.....	Utah	silver	10,000,000	25	5,642,000
Iron Silver.....	Colorado	all metals	10,000,000	20	4,250,000
Kerr Lake.....	Ontario	silver	3,000,000	5	2,430,000

THE BUSINESS OF MINING

CAPITALIZATION AND DIVIDENDS OF NORTH AMERICAN METAL MINES.—Continued.

Company	State or Country	Metals Produced	Capitalisation	Par Value per Share.	Dividends to Jan. 1, 1912.
La. Rose Con.....	Ontario	silver	\$7,500,000	\$5	\$2,890,912
Mammoth.....	Utah	gold, silver, copper	10,000,000	25	2,220,000
Mohawk.....	Michigan	copper	2,500,000	25	2,150,000
Mountain.....	California	copper	6,250,000	25	4,216,250
Naica.....	Mexico	silver, lead	30,000	300	3,190,000
Nevada Con.....	Nevada	copper	10,000,000	5	2,400,000
Nipissing.....	Ontario	silver	6,000,000	5	5,490,000
North Butte.....	Montana	copper, gold, silver	9,000,000	15	9,040,000
North Star.....	California	gold	2,500,000	10	2,786,988
Ontario.....	Utah	silver, lead	5,000,000	100	14,962,500
Osceola.....	Michigan	copper	2,500,000	25	8,958,650
Panuco.....	Mexico	gold, silver	2,000,000	10	7,465,000
Parrot.....	Montana	copper	2,300,000	50	6,991,138
Penoles.....	Mexico	silver, gold	2,000,000	100	4,741,687
Phelps, Dodge & Co.....	U. S.	copper	50,000,000	10	8,766,747
Phumas, Eureka.....	California	gold	1,406,250	1	2,831,294
Portland.....	Colorado	gold	3,000,000	1	8,677,080

NORTH AMERICAN METAL MINES

Quincy.....	Michigan	copper	3,750,000	25	19,330,000
Richmond.....	Nevada	gold, silver, lead	1,350,000	1	4,453,797
San Rafael.....	Mexico	gold, silver	60,000	25	3,218,338
Sta. Gertrudis.....	Mexico	gold, silver	3,000,000		3,960,000
Sta. Maria del Paz.....	Mexico	gold, silver	120,000	12.50	5,568,000
St. Joseph.....	Missouri	lead	20,000,000	10	7,208,357
Silver King Coalition.....	Utah	silver	6,250,000	5	12,522,385
Smuggler.....	Colorado	silver, lead, zinc	1,000,000	1	2,235,000
Standard Con.....	California	gold, silver	2,000,000	1	5,194,130
Stratton's Ind.....	Colorado	gold	5,500,000	5	5,028,568
Strong.....	Colorado	gold	1,000,000	1	2,275,000
Tamarack.....	Michigan	copper	1,500,000	25	9,420,000
Tennessee.....	Tennessee	copper	5,000,000	25	2,056,250
Tomboy.....	Colorado	gold, silver	1,500,000	5	2,561,000
Tonopah.....	Nevada	gold, silver	1,000,000	1	6,450,000
United.....	Montana	copper	50,000,000	100	7,625,000
United Verde.....	Arizona	copper	3,000,000	10	26,722,000
Utah Copper.....	Utah	copper	15,268,000	10	5,629,785
Utah Con.....	Utah	copper	1,500,000	5	6,900,000
Vindicator Con.....	Colorado	gold	1,500,000	1	2,227,500
Wolverine.....	Michigan	copper	1,500,000	25	6,300,000

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Mountain.	California	copper	6,250,000	25	4,216,250
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Nevada Con.	Nevada	copper	10,000,000	5	2,400,000
Nipissing.	Ontario	silver	6,000,000	5	5,490,000
North Butte.	Montana	copper, gold, silver	9,000,000	15	9,040,000
North Star.	California	gold	2,500,000	10	2,788,988
Ontario.	Utah	silver, lead	5,000,000	100	14,962,500
Oscuela.	Michigan	copper	2,500,000	25	8,958,650
Panuco.	Mexico	gold, silver	2,000,000		7,465,000
Parrot.	Montana	copper	2,300,000	10	6,991,188
Penoles.	Mexico	silver, gold	2,000,000	50	4,741,687
Phelps, Dodge & Co.	U. S.	copper	50,000,000	100	8,766,747
Plumas, Eureka.	California	gold	1,408,250	10	2,831,294
Portland.	Colorado	gold	3,000,000	1	8,677,080